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(54) NOVEL HYDRONAPHTHALENE COMPOUNDS, PREPARED BY A RHODIUM CATALYZED RING OPENING REACTION IN THE PRESENCE OF PHOSPHINE LIGAND

NEUE HYDRONAPHTHALENE, HERGESTELLT DURCH EINE RHODIUM-KATALYSIERTE RINGÖFFNUNGSREAKTION IN ANWESENHEIT EINES PHOSPHINLIGANDEN

NOUVEAUX COMPOSES HYDRONAPHTHALENE PREPARES PAR REACTION D'OUVERTURE DU CYCLE CATALYSE PAR LE RHODIUM EN PRESENCE D'UN LIGAND DE PHOSPHINE

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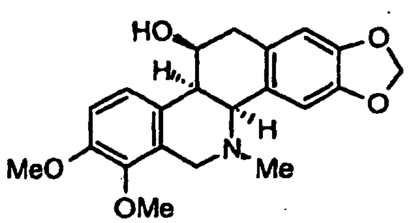
Description

Field of the Invention

[0001] The present invention is directed to methods for chemically synthesizing compounds containing a hydronaphthalene ring structure. It encompasses the compounds made by the methods.

Background of the Invention

[0002] The hydronaphthalene structure can be found in many natural products and pharmaceutical agents. These include homochelidonine **1** (Slavik, J.; *et al., Collect. Czech. Chem. Commun. 30*:3697 (1965); Spath, E., *et al., Ber., 64*:1123 (1931); Bersch, H. W., *Arch. Pharm.* (Weinheim, Ger.), *2914*:91 (1958)) an alkaloid isolated from Chelidonium plants, dihydrexidine **2** (Snyder, S. E., *J. Med. Chem., 38*:2395 (1995)) which shows antiparkinsonian character, etoposide 3 (Kamal, A., *et al., Tetrahedron Lett. 37*:3359 (1996)) which is used in the treatment of various cancers, and SF-2315B 4 (Kim, K., *et al., J. Org. Chem. 60*:6866 (1995)) which is a viral reverse transcriptase inhibitor. In addition, CNS agents, immunoregulatory agents and antibiotics contain variations on this framework (Perrone, R., *et al., J. Med. Chem. 38*:942 (1995)).



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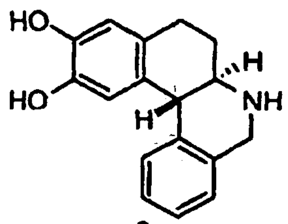

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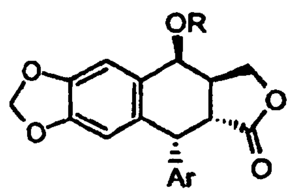

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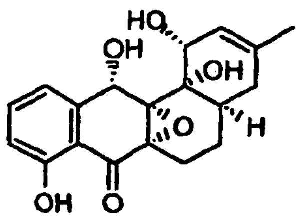

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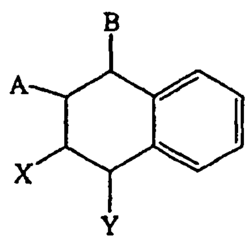
[0003] Given the large number of pharmaceutically useful compounds which contain this core skeleton, new methodology which produces functionalized hydronaphthalene skeletons (structure 1) would clearly be of value.



X, Y = O, N, C

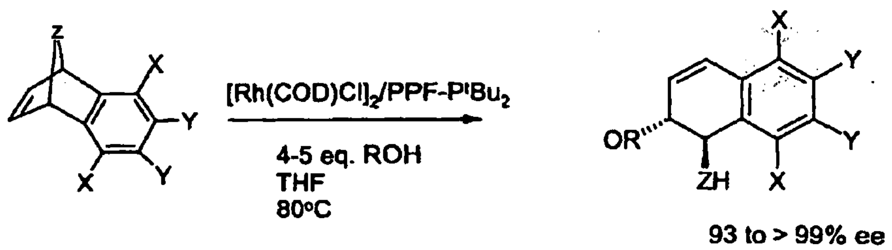
Structure 1

[0004] Previous work on oxabicyclic ring opening reactions led to a catalytic enantioselective route to dihydronaphthol (Lautens, M., *et al.*, *Tetrahedron 54*:1107 (1998)) which was a key step in the total synthesis of sertraline (Lautens, M., *et al.*, *J. Org. Chem. 63*:5276 (1997)). However, little is known about the ring opening of oxabenzonorbomadiene or similar compounds with the incorporation of nucleophiles during the ring opening step. Duan and Chen developed a method of introducing aryl groups by using catalytic amounts of palladium (Duan, J.-P., *et al.*, *Tetrahedron Lett., 34*: 4019 (1993); Duan, J.-P., *et al.*, *Organometallics* 14:1608 (1995)). Moinet *et al.*, later developed an enantioselective version of this reaction but the yields were low (*Tetrahedron Lett., 36*:2051 (1995)).

[0005] Catalytic organometallic processes that form carbon-heteroatom bonds are far fewer in number than those which form carbon-carbon bonds. The Wacker Process (Henry, P.M., Paladium Catalysed Oxidation of Hydrocarbons, vol. 2, Reidel, Boston, (1980)), oxidative carbonylations of amines and alcohols (Applied Homogeneous Catalysis with Organometallic Compounds: A Comprehensive Handbook in Two Volumes (eds.: B. Comils, W.A. Herrmann), VCH, New York, (1984)) and the formation of arylamines and aryl ethers (Hartwig, J.F., *Agnew. Chem. Int. Ed. 37*:2046 (1998); Widenhoefer, R.A., *et al.*, *J. Am. Chem. Soc. 119*:6787 (1997)) are a few that have been described to date.

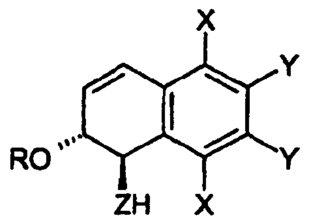
Summary of the Invention

[0006] The present invention is based upon the discovery of a rhodium catalyzed ring opening reaction of oxabenzonorbomadienes or azabicyclic compounds to produce a new carbon-oxygen bond via an intermolecular reaction with various alcohols. This reaction occurs in good yields with complete regio and diastereoselectivity and excellent enantioselectivity (*e.g.*, eq. 1).



Eq 1

[0007] In the reaction above, Z is O or NR_a. This reaction will work when oxabenzonorbomadienes are reacted with nitrogen nucleophiles, carboxylate nucleophiles, carbon nucleophiles or phenol nucleophiles. The invention encompasses not only the chemical reactions but also the compounds made by the reactions.
In its first aspect, the invention is directed to a compound according to formula I:



(I)

R is $-(CH_2)_nR_1$ and R_1 is a C_3-C_6 aryl optionally substituted at one or more positions with a group selected from: Cl; F; NO_2; I; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy and wherein n=0-3;

wherein X and Y are independently selected from the group consisting of H; NH_2; F; Cl; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy;

or wherein adjacent X and Y or Y and Y together with the carbon atoms to which they are attached from form a C_3-C_6 carbocyclic ring or a C_3-C_6 heterocyclic ring containing one or more heteroatoms selected from the group consisting of: O; N; and S; and

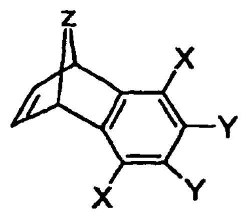
wherein Z is selected from O or NR_a, wherein R_a is selected from:

(i) phenyl;
(j) (O)C-O-R_b, wherein R_b is a straight or branched C_1-C_6 alkyl;
(k) -SO_2-R_c, wherein R_c is selected from the group consisting of:

i) C_1-C_6 straight or branched alkyl;
ii) -$(CH_2)_qR_e$, wherein q=O-3 and R_e is a C_3-C_6 aryl, optionally substituted at one or more positions with a group selected from: Cl; F; NO_2; CN; I; Br; a straight or branched C_1-C_3 alkyl; a C_1-C_3 alkoxy; and -C(O)R_f, wherein R_f is a C_1-C_3 alkyl; -$(CH_2)_rCF_3$, wherein r=0-3;
iii) -$R_g(CF_3)_s$, wherein R_g is a C_1-C_3 straight or branched alkyl and s=1-3;
iv) -$(CH_2)_s$-TMS, wherein TMS = trimethylsilyl and s= 1-3;

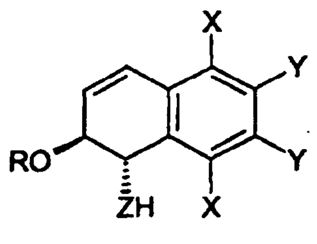
(l) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ wherein q is 1-3.

[0008] The compounds of formula I described above may be prepared by reacting a compound of formula ROH with a compound of formula V:



(V)

in which R, X, and Y are as defined above. The reaction is catalyzed by $[Rh(COD)Cl]_2$ in the presence of a phosphine ligand, preferably selected from the group consisting of: DPPF; (R)-(S)-BPPFA; and (R)-(S)-PPF-P^tBu_2. In prefered reactions: (a) the compound made is (1R*,2R*)-acetic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl ester and ROH is acetic acid; (b) the compound made is (1R*,2R*)-propionic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl ester and ROH is propionic acid; (c) the compound made is (1R,2R)-benzoic acid 1-hydmxy-1,2-dihydro-naphthalen-2-yl-ester and ROH is benzoic acid; (d) the compound made is (1R*,2R*)-formic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester and ROH is formic acid; (e) the compound made is (1R*,2R*)-2-methyl acrylic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester and ROH is methacrylic acid; (f) the compound made is (1R*,2R*)-malonic acid ethyl-ester (1-hydroxy-1,2-dihydro-naphthalen-2-yl) ester and ROH is ethyl malonic acid; and (g) the compound made is (1R,2R)-2-(4-bromo-phenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is p-bromophenol; (h) the compound made is N-[(1R,2S)-2-methoxy-1,2-dihydro-1-naphthalenyl]-2-(trimethylsilyl)ethanesulfonamide and ROH is MeOH; (i) the compound made is 4-methyl-N-[(1R, 2S)-2-phenoxy-1,2-dihydrohydro-1-naphthalenyl]bemzenesulfonamide and the ROH is phenol; (j) the compound made is (1R, 2S)-1-{[(4-methylpehnyl)sulfonyl]amino}-1,2-dihydrohydro-2-naphthalenyl acetate and the ROH is acetic acid; (k) the compound made is (1R, 2S)-1-{[(4-methylphenyl)-sulfonyl]amino}-1,2-dihydro-2-naphthalenyl benzoate and the ROH is benzoic acid; (l) the compound made is (1R, 2S)-1-{[(4-methylphenyl)sulfonyl]amino}-1,2-dihydro-2-naphthalenyl pivalate and the ROH is pivalic acid; (m) the compound made is N-[(1R, 2S)-2-methoxy-1,2-dihydro-1-naphthatenyl]-2-(trimethylsilyl)ethanesulfonamide and ROH is methanol.
In a second aspect the invention is directed to a compound according to formula II:



(II)

wherein R is -$(CH_2)_qR_5$ wherein q=0-3 and R_5 is a C_3-C_6 aryl optionally substituted at one or more positions with a group selected from: a straight or branched C_1-C_3 alkyl; a C_1-C_3 alkoxy; I; Cl; CN; F; NO_2; -$(CH_2)_rCF_3$, wherein r=0-3; and -C(O)R_6, wherein R_6 is a C_1-C_3 alkyl;

wherein X and Y are independently selected from the group consisting of H; NH_2; F; Cl; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy;

or wherein adjacent X and Y or Y and Y together with the carbon atoms to which they are attached from form a

C_3-C_6 carbocyclic ring or a C_3-C_6 heterocyclic ring containing one or more heteroatoms selected from the group consisting of: O; N; and S; and

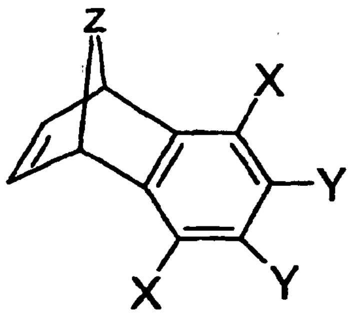
wherein Z is selected from O or NR_a, wherein R_a is selected from:

(e) phenyl;
(f) (O)C-O-R_b, wherein R_b is a straight or branched C_1-C_6 alkyl;
(g) -SO_2-R_c, wherein R_c is selected from the group consisting of:

i) C_1-C_6 straight or branched alkyl;
ii) -$(CH_2)_qR_e$, wherein q=0-3 and R_e is a C_3-C_6 aryl, optionally substituted at one or more positions with a group selected from: Cl; F; NO_2; CN; I; Br; a straight or branched C_1 -C_3 alkyl; a C_1-C_3 alkoxy; and -C(O)R_f, wherein R_f is a C_1-C_3 alkyl; -$(CH_2)_rCF_3$, wherein r=0-3;
iii) -$R_g(CF_3)_s$, wherein R_g is a C_1-C_3 straight or branched alkyl and s=1-3;
iv) -$(CH_2)_s$-TMS, wherein TMS = trimethylsilyl and s= 1-3;

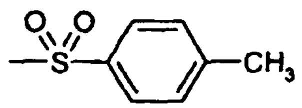
(h) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ wherein q is 1-3.

[0009] The compounds of formula II described above may be prepared by reacting a compound of formula ROH with a compound of formula V:



(V)

wherein R, X, Y, and Z are as defined above in connection with formula II and in which the reaction is catalyzed by [Rh (COD)Cl]$_2$ in the presence of a phosphine ligand, preferably (S)-(R)-PPF-P^{t}Bu$_2$. In preferred reactions: (a) the compound made is (1S,2S)-2-methoxy-1,2-dihydro-naphthalen-1-ol, and ROH is methanol; (b) the compound made is (1S, 2S)-2-(ethoxy)-1,2-dihydro-naphthalen-1-ol, and ROH is ethanol; (c) the compound made is (1S,2S)-2-isopropoxy)-1,2-dihydro-naphthalen-1-ol and ROH is isopropanol; (d) the compound made is (1S,2S)-2-1-propenyloxy)-1,2-dihydro-naphthalen-1-ol, and ROH is allyl alcohol; (e) the compound made is (1S,2S)-2-(2-trimethylsilyl-ethoxy)-1,2-dihydro-naphthalen-1-ol, and ROH is trimethylsilylethanol; (f) the compound made is (1S,2S)-2-benzyloxy-1,2-dihydro-naphthalen-1-ol, and ROH is benzylalcohol; (g) the compound made is (1S,2S)-2-4-methoxybenzyloxy-1,2-dihydro-naphthalen-1-ol, and ROH is anisylalcohol; (h) the compound made is (1S,2S)-2-(2,2,2-trifluoroethoxy)-1,2-dihydro-naphthalen-1-ol, and ROH is trifluoroethanol; (i) the compound made is (1S,2S)-2-(2,2,2-trifluoro-1-trifluoromethyl-ethoxy)-1,2-dihydro-naphthalen-1-ol and ROH is hexafluoro-isopropanol; (j) the compound made is (1S,2S)-6,7-difluoro-2-methoxy-1,2-dihydro-naphthalen-1-ol and ROH is methanol; (k) the compound made is (1S,2S)-6-methoxy-5,6-dihydro-naphtho[2,3-d][1,3]dioxol-5-ol and ROH is methanol; (1) the compound made is (1S,2S)-6,7-dibromo-2-methoxy-5,8-dimethyl-1,2-dihydro-riaphthalen-1-ol and ROH is methanol; (m) the compound made is (1S,2S)-2-phenoxy-1,2-dihydro-naphthalen-1-ol and ROH is phenol; (n) the compound made is (1S,2S)-2-(4-nitrophenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 4-nitrophenol; (o) the compound made is (1S,2S)-2-(4-cyanophenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 4-cyanophenol; (p) the compound made is (1S,2S)-2-(4-acylphenoxy)-1,2,-dihydro-naphthalen-1-ol and ROH is 4-hydroxyaceto-phenone; (q) the compound made is (1S,2S)-2-(4-trifluoromethylphenoxy)-1,2,-dihydro-naphthalen-1-ol and ROH is 4-trifluoromethylphenyl; (r) the compound made is (1S,2S)-2-(4-fluorophenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 4-fluorophenol; (s) the compound made is (1S,2S)-2-(4-chlorophenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 4-chlorophenol; (t) the compound made is (1S,2S)-2-(4-iodophenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 4-iodophenol; (u) the compound made is (1S,2S)-2-(4-methylphenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is p-cresol; (v) the compound made is (1S,2S)-2-(4-methoxyphenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 4-methoxyphenol; and (w) the compound made is (1S,2S)-2-(2-bromophenoxy)-1,2-dihydro-naphthalen-1-ol and ROH is 2-bromophenol. When Z is NR_a, R_a is preferably phenyl; (O)C-O-C-$(CH_3)_3$;



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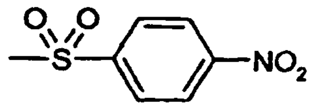
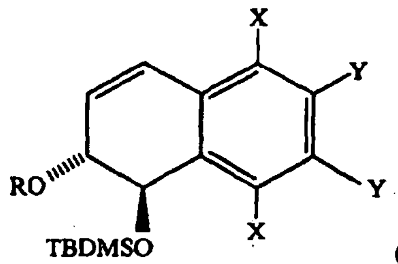


;

; or (O)S(O)-$(CH_2)_2$-Si$(CH_3)_3$.

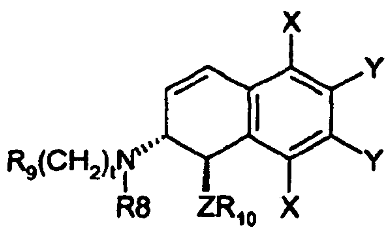
[0010] The invention is also directed to a compound according to formula III:



(III)

wherein TBDMSO is a tert-butyldimethylsiloxy group, and R, X, and Y are as defined in above in connection with formula I. These compounds may made by preparing a compound of formula I according to the process described above and then reacting the compound formed with a salt of tert-butytdimethylsilylic acid. Preferably, the compound formed is (1R*,2R*)-malonic acid (1-tert-butyldimethylsiloxy-1,2-dihydro-naphthalen-2-yl) ester ethyl ester and ROH is tert-butyldimethylsilylic acid.

[0011] In another aspect, the invention is directed to A compound according to formula IV:



(IV)

wherein:

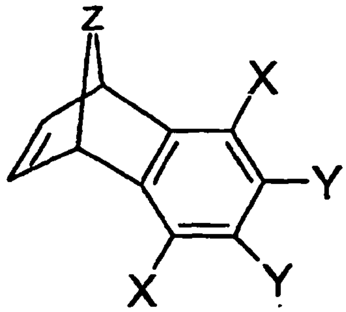
a) in which R_8 is H, CH_3 or as defined in c);
b) t=0-3;
c) R_9 is a C_3-C_6 aryl optionally substituted at one or more positions with a group selected from: a C_1-C_3 alkyl; a C_1-C_3 alkoxy; Cl; F; NO_2; and CF_3; or R_9 together with N, R_8 and $(CH_2)_t$ of formula IV forms a ring structure selected from: a phthalamide ring; a pyrrolidine ring; a piperidine ring; a tetrahydroquinoline ring; and an indole ring; said ring structure being optionally substituted at one or more positions with a group selected from: a C_1-C_3 alkyl; a C_1-C_3 alkoxy; Cl; F; NO_2; and CF_3;
d) X and Y are independently selected from the group consisting of H; NH_2; F; Cl; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy; or wherein adjacent X and Y or Y and Y together with the carbon atoms to which they are attached from form a C_3-C_6 carbocyclic ring or a C_3-C_6 heterocyclic ring containing one or more heteroatoms selected from the group consisting of: O; N; and S;

e) Z is selected from O or NR_a, wherein R_a is selected from:

(i) a straight or branched C_1-C_6 alkyl;
(ii) phenyl;
(iii) (O)C-O-R_b, wherein R_b is a straight or branched C_1-C_6 alkyl;
(iv) —SO_2-R_c, wherein R_c is an unsubstituted phenyl or a phenyl substituted with a C_1-C_3 alkyl or NO_2; and
(v) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ wherein q isl-3; and

f) when Z is O, R_{10} is H; when Z is NR_a, R_{10} is either H or CH_3.

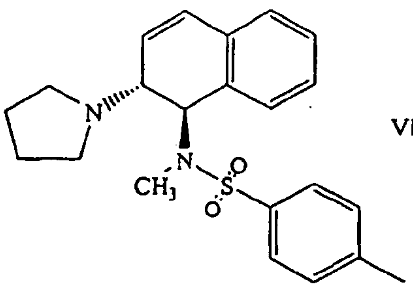
[0012] The compounds of formula IV described above may be prepared by reacting a compound of formula R_9-$(CH_2)_t$$NHR_8$ with a compound of formula V



(V)

in which R_8, R_9, t, X, Y, and Z are as defined above in connection with compounds of formula IV and the reaction is catalyzed by $[Rh(COD)Cl]_2$ in the presence of a phosphine ligand; preferably selected from the group consisting of: DPPF; (R)-(S)-BPPFA; and (R)-(S)-PPF-P^{t}Bu$_2$. When Z is NR_a, the reaction will produce a product in which R_{10} is H. A subsequent reaction may be used to convert R_{10} to a methyl as set forth in the Examples section below. Most typically, the process will be used to produce products in which R_9 together with N form a ring selected from the group consisting of: a phthalamide ring; a pyrrolidine ring; a piperidine ring; a tetrahydroquinoline ring; and an indole ring; said ring structures being optionally substituted at one or more positions with a group selected from: a C_1-C_3 alkyl; a C_1-C_3 alkoxy; Cl; F; NO_2; and CF_3. In preferred reactions: (a) the compound made is (1R,2R)-2-(1-hydroxy-1,2-dihydro-naphthalen-2-yl) isoindole-1,3-dione and R_9-$(CH_2)_s$$NHR_8$ is phthalimide; (b) the compound made is (1R*,2R*)-2-pyr-rolidin-1-yl-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_5$$NHR_8$ is pyrrolidine; (c) the compound made is (1R*,2R*)-2-pip-eridin-1-yl-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_s$$NHR_8$ is piperidine; (d) the compound made is (1R,2R)-2-(3,4-di-hydro-2H-quinolin-1-yl)-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_s$$NHR_8$ is tetrahydroisoquin-oline; (e) the compound made is (1R,2R)-2(methyl-phenyl-amino)-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_s$$NHR_8$ is N-methylaniline; (f) the compound made is (1R*,2R*)-2-benzylamino-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_s$$NHR_8$ is benzyl-amine; (g) the compound made is (1R*,2R*)-2-(4-methoxybenzylamino)-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_s$$NHR_8$ is p-methoxybenzylamine; and (h) the compound made is (1R,2R)-2-indol-1-yl-1,2-dihydro-naphthalen-1-ol and R_9-$(CH_2)_s$$NHR_8$ is indole; (i) the compound made is N-[1R,2R)-2(1-pyrrolidinyl)-1,2-dihydronaphthalenyl]-4-methyl-benzenesulfonamide and the R_9-$(CH_2)_t$$NHR_8$ is pyrrolidine; (j) the compound made is *N*-[(1*R*,2*S*)-2-(1*H*-indol-1-yl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide and the R_9-$(CH_2)_t$$NHR_8$ is indole; (k) the compound made is *N*-[(1*R*,2*S*)-2-(3,4-dihydro-2(1*H*)-isoquinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide and the R_9-$(CH_2)_t$$NHR_8$ is tetrahydroisoquinoline; (1) the compound made is *N*-[(1*R*,2*S*)-2-(3,4-dihydro-1(2*H*)-quinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide and the R_9-$(CH_2)_t$$NHR_8$ is tetrahydroquinoline; (m) the compound made is 4-methyl-*N*-[(1*R*,2*S*)-2-(1-piperidinyl)-1,2-dihydro-1-naphthalenyl]-benzenesulfonamide and the R_9-$(CH_2)_t$$NHR_8$ is piperidine.

[0013] The invention also encompasses seven other processes. In the first (1S,2S)-N-(1-hydroxy-1,2-dihydro-naph-thalen-2-yl)-benzene sulfonamide is formed by reacting oxabenzonorbomadiene with benzenesulfonamide. In the sec-ond, (1S*,2R*)-2-(hydroxy-1,2-dihydro-naphthalen-2-yl)malonic acid dimethyl ester is formed by reacting oxaben-zonorbornadiene with dimethyl malonate. Both reactions are catalyzed by $[Rh(COD)Cl]_2$ in the presence of a phosphine ligand. In the third, the compound of formula VI is formed by reacting a compound of formula IV, which is produced as described above in connection with formation of compounds of formula IV, with iodomethane. In preferred reactions, the compound made is N,4-dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]benzenesulfonamide. In the fourth, the compound of formula VII is formed by reacting compound of formula VI with hydrogen in the presence of palladium catalyst. The compound made is N,4-dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenyl]benzenesulfonamide. In the fifth, the compound of formula VIII is formed by reacting the compound of formula VII with sodium borohydride. The compound made using this reaction is (1*R*,2*S*)-*N*-methyl-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenamine. In the sixth, the compound of formula IX is formed by reacting a compound of formula IV which is produced as described above in connection with formation of compounds of formula IV, with iodomethane. The compound made using this reaction is N-methyl-4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl] benzenesulfonamide. In the seventh, the compound of formula X is formed by reacting a compound of formula I which is produced as described above in connection with formation of compounds of formula I, with iodomethane. The compound made using this reaction is (1*R*,2*S*)-1-{methyl[(4-methylphenyl)sulfonyl]amino}-1,2-dihydro-2-naphthalenyl acetate.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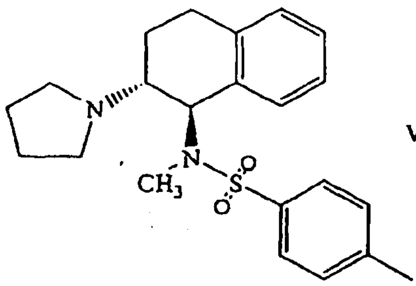
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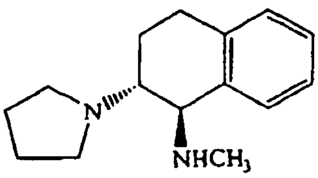
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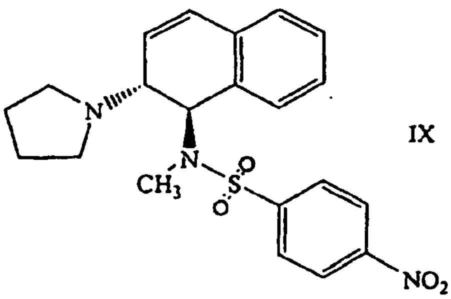
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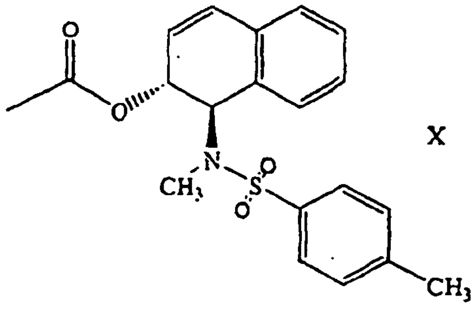

X

[0014] Overall, the most preferred compounds of the invention are:

a) (1S,2S)-2-methoxy-1,2-dihydro-naphthalen-1-ol;
b) (1S,2S)-2-(ethoxy)-1,2-dihydro-naphthalen-1-ol;

c) (1S,2S)-2-(isopropoxy)-1,2-dihydro-naphthalen-1-ol;
d) (1S,2S)-2-(1-propenyloxy)-1,2-dihydro-naphthalen-1-ol;
e) (1S,2S)-2-(2-trimethylsilyl-ethoxy)1,2-dihydro-naphthalen-1-ol;
f) (1S,2S)-2-benzyloxy-1,2-dihydro-naphthalen-1-ol;
g) (1S,2S)-2-(4-methoxybenzyloxy)-1,2-dihydro-naphthalen-1-ol;
h) (1S,2S)-2-(2,2,2-trifluoro-ethoxy)-1,2-dihydro-naphthalen-1-ol;
i) (1S,2S)-2-(2,2,2-trifluoro-1-trifluoromethyl-ethoxy)-1,2-dihydro-naphthalen-1-ol;
j) (1S,2S)-6,7-difluoro-2-methoxy-1,2-dihydro-naphthalen-1-ol;
k) (1S,2S)-6-methoxy-5,6-dihydro-naphthol[2,3-d][1,3]dioxol-5-ol;
l) (1S,2S)-6,7-dibromo-2-methoxy-5,8-dimethyl-1,2-dihydro-naphthalen-1-ol;
m) (1R*,2R*)-acetic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
n) (1R*,2R*)-propionic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
o) (1R,2R)-benzoic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
p) (1R*,2R*)-formic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
q) (1R*,2R*)-2-methyl acrylic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
r) (1R*,2R*)-malonic acid ethyl ester (1-hydroxy-1,2-dihydro-naphthalen-2-yl) ester;
s) (1R*,2R*)-malonic acid (1-tert-butylbimethylsiloxy-1,2-dihydro-naphthalen-2-yl) ethyl ester;
t) (1S*,2S*)4-tert-butyldimethylsiloxy-1,4-dihydro-naphthalen-2-yl) acetic acid ethyl ester;
u) (1R,2R)-2-(1-hydroxy-1,2-dihydro-naphthalen-2-yl)-isoindote-1,3-dione;
v) (1S,2S)-N-(1-hydroxy-1,2-dihydro-naphthalen-2-yl)-benzene sulfonamide;
w) (1R*,2R*)-2-pyrrolidin-1-yl-1,2-dihydro-naphthalen-1-ol;
x) (1R*,2R*)-2-piperidin-1-yl-1,2-dihydro-naphthalen-1-ol;
y) (1R,2R)-2-(3,4-dihydro-2H-quinolin-1-yl)-1,2-dihydro-naphthalen-1-ol;
z) (1R,2R)-2-(methyl-phenyl-amino)-1,2-dihydro-naphthalen-1-ol;
aa) (1R*,2R*)-2-benzylamino-1,2-dihydro-naphthalen-1-ol;
bb) (1R*,2R*)-2-(4-methoxy-benzylamino)-1,2-dihydro-naphthalen-1-ol;
cc) (1R,2R)-2-indol-1-yl-1,2-dihydro-naphthalen-1-ol;
dd) (1S*,2R*)-2-(hydroxy-1,2-dihydro-naphthalen-2-yl)malonic acid dimethyl ester;
ee) (1S,2S)-2-phenoxy-1,2-dihydro-naphthalen-1-ol;
ff) (1S,2S)-2-(4-nitrophenoxy)-1,2-dihydro-naphthalen-1-ol;
gg) (1S,2S)-2-(4-cyanophenoxy)-1,2-dihydro-naphthalen-1-ol;
hh) (1S,2-S)-2-(4-acylphenoxy)-1,2-dihydro-naphthalen-1-ol;
ii) (1S,2S)-2-(4-trifluoromethylphenoxy)-1,2-dihydro-naphthalen-1-ol;
jj) (1S,2S)-2-(4-fluorophenoxy)-1,2-dihydro-naphthalen-1-ol;
kk) (1S,2S)-2-(4-chlorophenoxy)-1,2-dihydro-naphthalen-1-ol;
ll) (1S,2S)-2-(4-iodophenoxy)-1,2-dihydro-naphthalen-1-ol;
mm) (1R,2R)-2-(4-bromo-phenoxy)-1,2-dihydro-naphthalen-1-ol;
nn) (1S,2S)-2-(4-methylphenoxy)-1,2-dihydro-naphthalen-1-ol;
oo) (1S,2S)-2-(4-methoxyphenoxy)-1,2-dihydro-naphthalen-1-ol;
pp) (1S,2S)-2-(2-bromophenoxy)-1,2-dihydro-naphthalen-1-ol;
qq) 4-methyl-*N*-[(1*R*,2*S*)-2-(1-piperidinyl)-1,2-dihydro-1-naphthalenyl]benzenesulfonamide;
rr) *N*-[(1*R*,2*S*)-2-(3,4-dihydro-1(2*H*)-quinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
ss) *N*-[(1*R*,2*S*)-2-(3,4-dihydro-2(1*H*)-isoquinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
tt) *N*-[(1*R*,2*S*)-2-(1*H*-indol-1-yl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
uu) (1*R*,2*S*)-2-methoxy-*N*-phenyl-1,2-dihydro-1-naphthalenamine;
vv) *tert*-butyl (1*R*,2*S*)-2-methoxy-1,2-dihydro-1-naphthalenylcarbamate;
ww) *N*-[(1*R*,2*S*)-2-methoxy-1,2-dihydro-1-naphthalenyl]-2-(trimethylsilyl)ethanesulfonamide;
xx) *N*,4-dimethyl-*N*-[(1*R*,2*S*)-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenyl]-benzenesulfonamide;
yy) *N*,4-dimethyl-*N*-[(1*R*,2*S*)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]-benzenesulfonamide;
zz) *N*-hydroxy-4-({methyl[(1*R*,2*S*)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]amino}sulfonyl)-*N*-oxobenzenaminium;
aaa) N,4-dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]-benzenesulfonamide;
bbb) N-hydroxy-4-({methyl[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyllamino}sulfonyl)-N-oxobenzenaminium;
ccc) N-methyl-4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]-benzenesulfonamide;
ddd) (1R,2S)-N-methyl-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenamine;
eee) N-[(1R, 2S)-2-methoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
fff) N-[(1R,2S)-2-methoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzenesulfonamide;

ggg) 4-methyl-N-[(1R,2S)-2-phenoxy-1,2,3,4-tetrahydro-1-naphthalenyl]benzenesulfonamide;
hhh) (1R,2S)-1-{[(4-methylphenyl)sulfonyl]amino)-1,2,3,4-tetrahydro-2-naphthalenyl acetate;
iii) (1R,2S)-1-{[(4-methylphenyl)sulfonyl]amino}-1,2-dihydro-2-naphthalenyl benzoate;
jjj) (1R,2S)-1-{[(4-methylphenyl)sulfonyl]amino1,2-dihydro-2-naphthalenyl pivalate;
kkk) N-[(1R,2S)-2-methoxy-1,2-dihydro-1-naghthalenyl]-2-(trimethylsilyl)ethanesulfonamide;
lll) tert-butyl (1R,2S)-2-methoxy-1,2-dihydro-1-naphthalenylcarbamate; and
mmm) 4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]benzenesulfonamide.

Detailed Description of the Invention

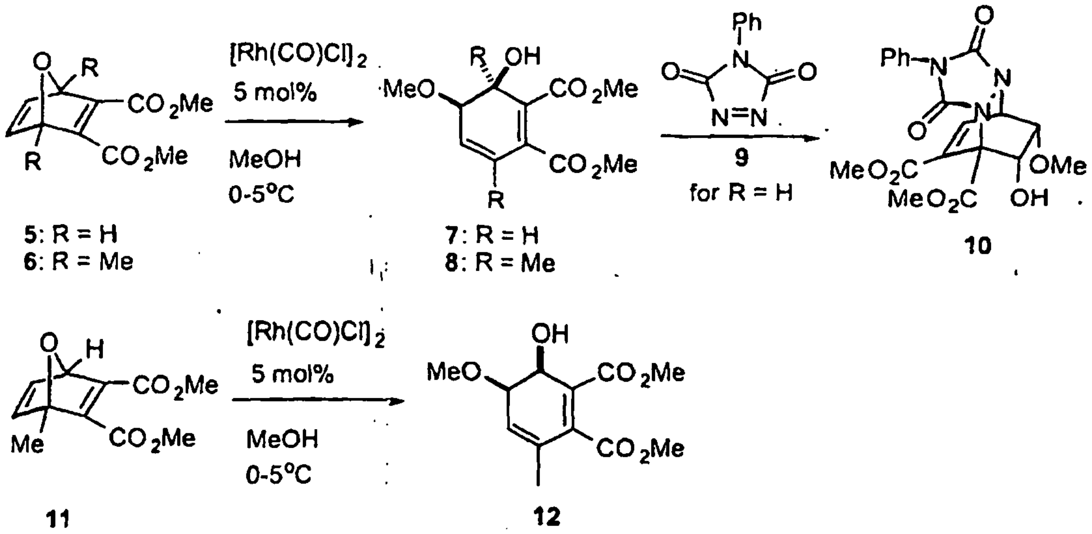
[0015] The present invention is based upon the discovery of a new process for the formation of enantiomerically enriched compounds containing the hydronaphthalene ring structure. The process involves reacting an oxabenzonorbomadiene with a nucleophile in the presence of a rhodium catalyst and a phosphine ligand. Detailed procedures for the formation of oxabenzonorbomadiene compounds and their use in reactions are set forth in the Examples section below. Preferred nucleophiles are alcohols, phenols, amines, and stabilized carbanions such as malonates and malonate equivalents. In cases where simple aliphatic amines are used, reactions should be performed in the presence of a tertiary amine hydrochloride. This is not necessary for other types of amines. When carboxylic acids are used, reactions should be carried out in the presence of a tertiary amine, e.g., triethylamine. Alternatively, the sodium or potassium salt of the carboxylic acid may be reacted in the presence of the hyrochloride of a tertiary amine, *e.g.* in the presence of triethylamine hydrochloride. It has been found that carboxylate ring-opened products can be made to undergo a subsequent transformation to produce 1,4-disubstituted dihyronaphthalenes. This is accomplished by an S_N2' addition of nucleophiles under catalytic or non-catalytic conditions to the allyl acetate functionality. For an example of the conversion of (1R*,2R*)-Malonic acid (1-tert-butyldimethylsiloxy-1,2-dihydro-naphthalen-2-yl) ester ethyl ester to (1S*,2S*)-(4-Tert-butyidimethylsiloxy-1,4-dihydro-naphthalen-2-yl) acetic acid ethyl ester see the Examples section below.

[0016] The preferred catalyst is $[Rh(COD)Cl]_2$ and, depending upon the particular product desired, preferred ligands are DPPF or a chiral analogue of DPPF, (R)-(S)-BPPFA; (R)-(S)-PPF-P^tBu_2 and (S)-(R)-PPF-P^tBu_2. The ligands may be prepared by any process described in the literature (*see, e.g.*, Togni *et al.*, *J. Am. Chem. Soc. 116*:4062 (1994)). Reactions may be carried out using trifluoroethanol (TFE) or tetrahydrofuran (THF) as solvents under an inert atmosphere, preferably of nitrogen. The reaction temperature should typically be at least 60°C and preferably about 80°C.

Examples

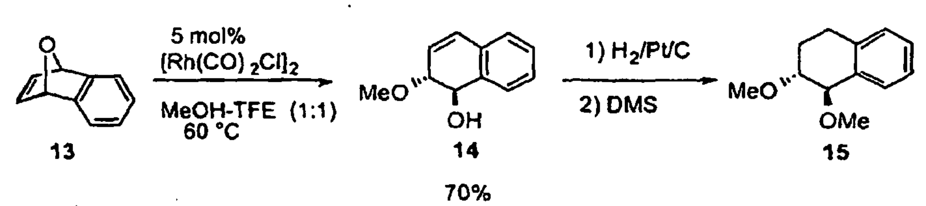
Example 1: Rhodium Catalysed Synthesis of Enatiomerically Enriched *trans*-2-Alkoxy-1,2-dihydro-naphthalen-1-ols

[0017] In 1973, Hogeveen and Middelkoop reported a $[Rh(CO)_2Cl]_2$ catalyzed ring opening reaction of **5** by reaction with methanol giving **6**. (Hogeveen, H., *et al.*, *Tetrahedron Lett. 190*:1 (1973)) Subsequently, Ashworth and Berchtold reported the stereochemistry of this reaction to be cis as shown after the formation of a Diels-Alder adduct with **9** (scheme 1) (Ashworth, R. W., *et al.*, *Tetrehedron Lett.* 339 (1977)). This stereochemistry is in keeping with the observation of exo attack by nucleophiles with other oxabicyclic starting materials (Lautens, M., *Synlett* 179 (1993)). Hogeveen and Middelkoop also reported that the reaction was regioselective when only one of the bridgehead positions was substituted, that is **11** gave only regioisomer **12.**



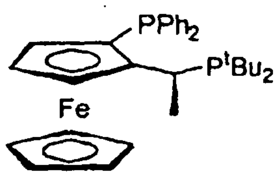
Scheme 1

[0018] When **13** (Stiles, M., *et al.*, *J. Am. Chem. Soc.* *82*:3802 (1960)) was subjected to the Hogeveen and Middelkoop conditions, no reaction was observed. However, by changing the solvent system to a 1:1 mixture of trifluoroethanol (TFE):methanol and by increasing the temperature to 60°C, the desired product **14** was isolated in 70% yield. Remarkably, the stereochemistry of **14** was trans as proven by comparison with authentic samples of both stereoisomers of dimethoxytetrahydronaphthalene **15** (eq. 2) (The cis isomer of **15** was prepared by reaction of 1,2-dihydronaphthalene with OSO_4 followed by methylation with dimethylsulfate (DMS). The trans isomer was prepared by epoxidation of 1,2-dihydronaphthalene followed by ring opening with hyroxide and dimethylation with DMS).



Eq 2

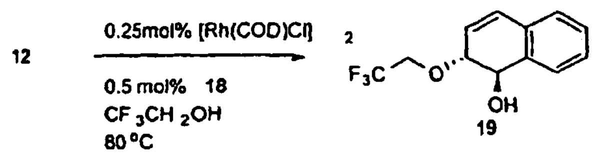
[0019] Given the ability of this reaction to set up two stereocentres with complete regio and stereocontrol, the possibility of rendering it asymmetric was investigated. A serious drawback of the existing catalyst $[Rh(CO)_2Cl]_2$, however, was that the addition of phosphine ligands completely inhibited the reaction. By changing to a rhodium source possessing the more labile COD ligand, $[Rh(COD)Cl]_2$, it was possible to examine the catalytic ability of several chiral phosphine ligands. Not all rhodium-ligand combinations performed equally well. DPPE and BINAP did not produce the desired product, and phosphites resulted in poor yields. DPPF was very efficient, however, giving **14** in 88% yield. One advantage of DPPF is that a number of chiral analogues have been prepared and could be studied to determine enantioselectivity. JOSIPHOS ligands (Togni, A.., *et al.*, *J Am. Chem. Soc.* *116*:4062 (1994)) were among the chiral ligands examined which gave the most promising results. For example, PPF-P^tBu_2 16 gave **14** in 84% yield and 86% ee at 60°C. The ee could be significantly improved to 97% when the reaction temperature was increased by 20°C.



PPF-P^tBu_2
18

[0020] These reactions were typically run as a 1:1 mixture of MeOH:TFE under a nitrogen atmosphere which gave **13** accompanied by small amounts of naphthol. In neat trifluoroethanol under a nitrogen atmosphere, naphthol is the major product with less than 5% conversion to the trifluoroethanol ring-opened product. Remarkably, this is not the case when the reaction is run under a carbon monoxide atmosphere. In the presence of CO, the reaction with neat TFE gives the TFE ring-opened product **17** in 70% yield after 3 hours. A colour change of the solution, from yellow to red was observed, suggesting that the CO was interacting with the rhodium metal. When the reaction was performed under asymmetric conditions using PPF-P^tBu_2, **17** was obtained in 70% yield and 98% ee indicating that the ligand remains bound to the metal even if CO binding has occurred (table 1).

Table 1: Effects of Sovlent and Atmosphere

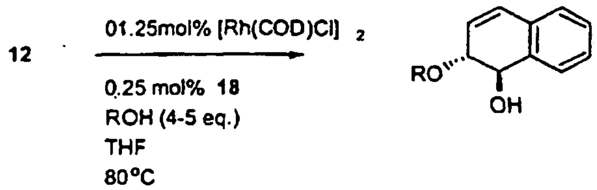


Atmosphere	Solvent / Equiv. TFE	Yield 19	ee
N_2	TFE / neat	0%*	
CO	TFE / neat	70%	98%
N_2	THF / 5 eq. TFE	70%	98%

* only product observed is naphthol

[0021] Reactions run in alcohols other that TFE proceeded at a much slower rate. When the solvent was changed to THF, the reaction worked equally well with a broad range of alcohols under racemic and enantioselective conditions, and only five equivalents of the alcohol were required. THF also allowed the use of very low catalyst loadings, typically in the range of 0.125 mol% of $[Rh(COD)Cl]_2$ and 0.25 mol% of **16**. While TFE would only add to give 17 when the reaction was run under a CO atmosphere in neat TFE, this was not the case in THF. When THF was used as the solvent, TFE added efficiently under an inert nitrogen atmosphere to give **17** in 70% yield and 98% ee. Even the very weakly nucleophilic hexafluoroisopropanol (HFI) added under these reaction conditions to give **23** in 90% yield and 93% ee (table 2).

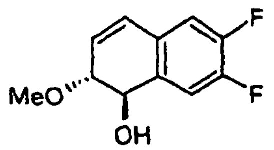
Table 2: Rhodium Catalysed Ring Opening of 12 with Various Alcohols



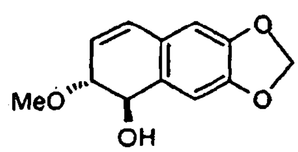
ROH	Product	Yield(%)	ee(%) [b]
MeOH [a]	14	96	97
EtOH [a]	16	84	97
^{i}PrOH [a]	18	94	93
Allyl Alcohol	19	92	>99
TMS Ethanol [a]	20	53	95
Benzyl Alcohol	21	66	>98
p-Methoxybenzyl Alcohol	22	87	97
TFE	17	70	98
HFI	23	90	93

[a] These reactions were performed under unoptimised conditions using 10 eq. ROH
[b] ee determined by formation of Moshers ester or by HPLC analysis with a Chiralcel OD column

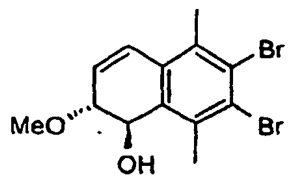
[0022] In order to investigate the effects of substituents on the aromatic ring of 13, difluoro (24), methylenedioxy (**25**), and dimethyldibromo (**26**) substrates were prepared (Hart, H., *Tetrahedron 43*:5203 (1987)) and reacted them under the standard conditions. All gave the corresponding ring opened products in good yields and excellent ee's (chart 1) indicating that this reaction is not sensitive to remote substitution or electronic effects on the aromatic ring.



27
90% yield
95%ee



28
88% yield
96%ee

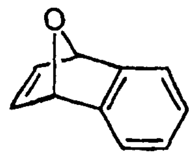


29
79% yield
97%ee

Chart 1

Example 2: Formation of 1,4-epoxy-1,4-dihydronaphthanlene (13)

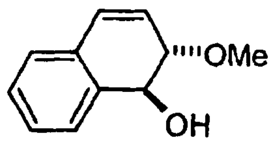
[0023]



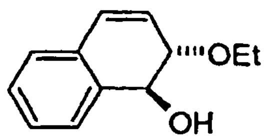
[0024] To furan (100 ml, 1.37 ml) in DME (100 ml) at 50°C in a flame dried three neck flask with a reflux condenser and two addition funnels attached was added simultaneously over two hours a solution of anthranilic acid (27.5 g, 200 mmol) in DME (100 ml) and a separate solution of isoamylnitrite (40 mL, 298 mmol) in DME (50 mL). Upon completion of addition, the reaction was allowed to stir at 50°C for 30 min until no further gas was evolved. The reaction mixture was then cooled to room temperature and portioned between Et_2O and saturated K_2CO_3 and the aqueous layer was extracted three times with Et_2O. The combined organic layer were washed with brine, dried over $MgSO_4$ and concentrated. Bulb to bulb distillation gave **13** (18.5 g, 64%) as a white solid. The spectral data correspond well with the literature data.[17]

Example 3: Compounds Formed by Reactions Involving Alcohols

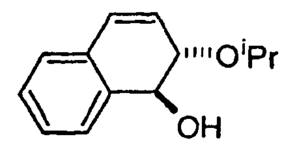
[0025]



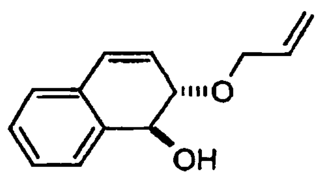
[0026] (1S,2S)-2-Methoxy-1,2-dihydro-naphthalen-1-ol (14) To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (0.5 mg, 0.0009 mmol), (R)-(S)-PPF-P^tBu_2 (1.0 mg, 0.0018 mmol) and 13 (27 mg, 0.187 mmol) were added followed by addition of THF (0.5 mL) and methanol (0.5 mL). The mixture was heated for 15 hours and the solvents were *removed in vacuo*. The resulting solid was purified by flash chromatography (20% ethyl acetate in hexanes) to give **14** a white crystalline solid (31.7 mg, 96%). The ee was determined to be 97% using HPLC analysis on a CHIRALCEL OD column, λ= 486 nm. Retention times in 4% isopropanol in hexanes were 10.1 min (major) and 11.1 min. R_f= 0.29 on silica gel (10% ethyl acetate:hexanes); mp 86-87° (Et_2O); $[\alpha]^{25}{}_D$=-208° (c= 10.1, $CHCl_3$); R_f= 0.39 on silica (20% ethyl acetate:hexanes). IR (KBr, cm^{-1}) 3277 (br), 2971 (m), 1466(m), 1285(m), 1114(s), 1048(m), 979(m), 775(s); ^1H NMR (400MHz, acetone-d) δ 7.60-7.62 (1H, m), 7.30-7.21 (2H, m), 7.13-7.11 (1H, m), 6.50 (1H, dd, J= 9.9,1.8 Hz), 6.04 (1H, dd, J= 9.9, 2.2 Hz), 4.85 (1H, dd, J= 9.9, 6.2 Hz), 3.50 (3H, s), 2.89 (1H, d, J= 12.8 Hz); ^{13}C NMR (400MHz, acetone-d) δ 138.5, 133.2, 129.1, 128.4, 128.3, 128.2, 126.8, 126.3, 83.1, 73.0, 57.1. HRMS calcd for $C_{11}H_{12}O_2$ (M^+): 176.0837. Found: 176.0835.



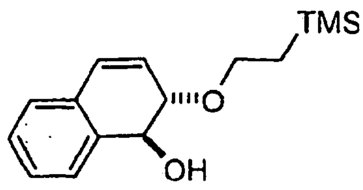
[0027] (1S,2S)-2-(Ethoxy)-1,2-dihydro-naphthalen-1-ol (16): : To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (2.1 mg, 0.043 mmol), (S)-(R)-PPF-P^tBu_2 (3.8 mg, 0.087 mmol) and **13** (500 mg, 3.47 mmol) were added followed by addition of ethanol (4 mL) and THF (4 mL). The mixture was heated to reflux for five hours and the solvent was removed *in vacuo*. The resulting solid was purified by flash chromatography (20% ethyl acetate in hexanes) to give **16** as a white crystalline solid (553 mg, 84%). The ee was determined to be 97% using HPLC analysis on a CHIRALCEL OD column, λ = 254 nm. Retention times in 1.5% isopropanol in hexanes were 13.6 min and 14.2 min (major). R_f= 0.26 on silica gel (20% ethyl acetate:hexanes); mp 33° (Et_2O); $[\alpha]^{25}_D$= 185.9° (c= 9.6, $CHCl_3$); IR (KBr, cm^{-1}) 3601 (br), 3040 (m), 2977 (s), 1454 (s), 1396 (m), 1185 (s), 1104 (s); ^1H NMR (400MHz, $CDCl_3$) δ 7.59-7.57 (1H, m), 7.27-7.20 (2H, m), 7.07-7.05 (1H, m), 6.43 (1H, dd, *J*= 9.9, 2.2 Hz), 6.01 (1H, dd, *J*= 9.9, 2.2 Hz), 4.90 (1H, d, *J*= 10.6 Hz), 4.18 (1H, ddd, *J*= 10.6,2.2,2.2 Hz), 3.79 (1H, AB, dq, *J*= 9.4, 6.9 Hz),), 3.58 (1H, AB, dq, *J*= 9.4, 6.9 Hz), 2.65 (1H, s), 1.27 (3H, t, *J*= 6.9 Hz),; ^{13}C NMR (400MHz, $CDCl_3$) δ 135.9, 131.9, 128.0, 127.8, 127.8, 126.1, 124.9, 80.7, 72.5, 64.6, 15.5. HRMS calcd for $C_{12}H_{14}O_2$ (M^+): 190.0994. Found: 190.0993.



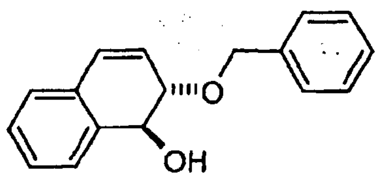
[0028] (1S,2S)-2-(Isopropoxy)-1,2-dihydro-naphthalen-1-ol (18): : To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (3.5 mg, 0.007 mmol), (S)-(R)-PPF-P^tBu_2 (7.5 mg, 0.014 mmol) and **13** (100 mg, 0.694 mmol) were added followed by addition of THF (1.5 mL) and isopropanol (1.5 mL). The mixture was heated to 80°C for two hours and the solvent was removed *in vacuo*. The resulting oil was purified by flash chromatography (10% ethyl acetate in hexanes) to give **18** as a colourless oil (133.7 mg, 94%). The ee was determined to be 92% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 1.5% isopropanol in hexanes were 9.7 min (major) and 10.7 min. R_f= 0.42 on silica gel (10% ethyl acetate:hexanes); $[\alpha]^{25}_D$= +154.0° (c= 12.6, $CHCl_3$); IR (KBr, cm^{-1}) 3435(br), 3038(w), 2952(s), 1454(m), 1249(s), 1087(s); ^1H NMR (400MHz, $CDCl_3$) δ 7.61-7.58 (1H, m), 7.27-7.19 (2H, m), 7.06-7.04 (1H, m), 6.40 (1H, dd, *J*= 9.9, 2.0 Hz), 5.95 (1H, dd, *J*= 9.9, 2.2 Hz), 4.87 (1 H, d, *J*= 10.8 Hz), 4.24 (1H, ddd, *J*= 10.8, 2.2,2.2 Hz), 3.85 (1H, h, *J*= 6.2 Hz), 2.98 (1H, s), 1.25 (6H, dd, *J*= 8.8, 6.2 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ136.2, 132.3, 129.6, 128.0, 127.9, 127.8, 126.3, 125.0, 78.9, 73.0, 71.1, 23.5, 22.4. HRMS calcd for $C_{13}H_{16}O_2$ (M^+): 204.1150. Found: 204.1150.



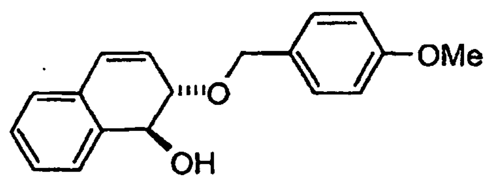
[0029] (1S,2S)-3-(1-propenyloxy)-1,2-dihydro-naphthalen-1-ol (19): : To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (9.1 mg, 0.018 mmol), (S)-(R)-PPF-P^tBu_2 (15 mg, 0.028 mmol) and **13** (1.06 g, 7.35 mmol) were added followed by addition of THF (1.5 mL) and allyl alcohol (2 mL, 29.4 mmol). The mixture was heated to 80°C for two hours and the THF was removed *in vacuo*. The resulting oil was purified by flash chromatography (10% ethyl acetate in hexanes) to give **19** as a colourless oil (898mg, 60%) which solidified on sitting. The ee was determined to be >99% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 1.5% isopropanol in hexanes were 15.2 min and 16.3 min (major). R_f= 0.17 on silica gel (10% ethyl acetate:hexanes); mp 25-26° (Et_2O); $[\alpha]^{25}_D$= +195.1° (c= 11.5, $CHCl_3$); IR (KBr, cm^{-1}) 3435(br), 3037(m), 2857(s), 1454(s), 1165(s), 1083(s); ^1H NMR (400MHz, $CDCl_3$) δ 7.61-7.58 (1H, m), 7.27-7.20 (2H, m), 7.08-7.05 (1H, m), 6.44 (1H, dd, *J*= 9.9, 2.0 Hz), 6.00 (1H, dd, *J*= 9.9, 2.4 Hz), 6.00-5.92 (1H,m), 5.32 (1 H, ddd, *J*= 17.2, 3.3, 1.6 Hz), 5.21 (1H, ddd, *J*= 10.4, 2.9, 1.3 Hz), 4.94 (1H, d, *J*= 10.2 Hz), 4.27 (1H, ddd, *J* = 10.3, 2.2, 2.2 Hz),), 4.23 (1H, dddd, *J* = 12.8, 5.5, 1.5, 1.5 Hz), 4.12 (1H, dddd, *J* = 12.8, 5.9, 1.5, 1.5 Hz), 3.09 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ135.8, 134.5, 131.8, 128.1, 127.7, 127.6, 127.4, 126.1, 125.0, 117.5, 80.1, 76.7, 72.4, 70.2. HRMS calcd for $C_{14}H_{14}O_2$ (M^+):202.0994. Found: 202.0994.



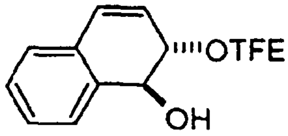
[0030] (1S,2S)-2-(2-Trimethylsilyl-ethoxy)-1,2-dihydro-naphthalen-1-ol (20): : To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), (S)-(R)-PPF-P^tBu_2 (9.4 mg, 0.0174 mmol) and **13** (100 mg, 0.694 mmol) were added followed by addition ofTHF (1.25 mL) and trimethylsilylethanol (1.25 mL). The mixture was heated to reflux for two hours and the THF was *removed in vacuo*. The resulting oil was purified by flash chromatography (10% ethyl acetate in hexanes) to give **20** as a colourless oil (84.7 mg, 53%). The ee was determined to be 95% using HPLC analysis on a CHIRALCEL OD column, λ = 486nm. Retention times in 0.5% isopropanol in hexanes were 17.9 min and 18.5 min (major). R_f= 0.25 on silica gel (10% ethyl acetate:hexanes); $[\alpha]^{25}_D$= +119.2° (c= 13.0, $CHCl_3$); IR (KBr, cm^{-1}) 3447(br), 3037(m), 2972(s), 1454(m), 1381(m), 1118(s), 1078(s); ^1H NMR (400MHz, $CDCl_3$) δ 7.59-7.57 (1H, m), 7.28-7.21 (2H, m), 7.08-7.06 (1H, m), 6.43 (1H, dd, *J*= 9.9, 2.0 Hz), 6.03 (1H, dd, *J*= 9.9, 2.2 Hz), 4.89 (1 H, d, *J*= 10.6 Hz), 4.18 (1H, ddd, *J*= 10.6, 2.2, 2.2 Hz), 3.85-3.78 (2H, m), 3.63-3.56 (2H, m), 2.79 (1H, s), 1.05-0.97 (2H, m), 0.36 (9H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ. 135.9, 132.0, 127.9, 127.9, 127.8, 127.6, 126.1, 124.9, 80.4, 72.6, 66.5, 18.6, -1.4. HRMS calcd for $C_{15}H_{22}O_2Si$ (M^+): 262.1389. Found: 262.1388.



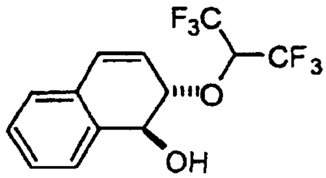
[0031] (1S,2S)-2-Benzyloxy-1,2-dihydro-naphthalen-1-ol (21): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (9.0 mg, 0.018 mmol), (S),(R)-PPF-P^tBu_2 (19.0 mg, 0.035 mmol), and **13** (1.00 g, 6.94 mmol) were added followed by addition of THF (1.8 mL) and benzylalcohol (3.6 mL, 34.7 mmol) and heating to 80°C for 24 hours. The THF was then removed *in vacuo* and the resulting oil was purified by flash chromatography (10% ethyl acetate in hexanes) to give **21** as a crystalline solid (1.22 g, 70%). The ee was determined to be >98% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 1.5% isopropanol in hexanes were 29.0 min and 32.5 min (major). R_f= 0.34 on silica gel (20% ethyl acetate:hexanes); mp 52-54° (Et_2O); $[\alpha]^{25}_D$= +167.3° (c= 10.0, $CHCl_3$); IR (KBr, cm^{-1}) 3305 (br), 3020 (w), 2876 (w), 1496 (m), 1352 (m), 1281 (m), 1169 (m), 1050 (s), 777 (s); ^1H NMR (400MHz, $CDCl_3$) δ 7.58-7.56 (1H, m), 7.41-7.22 (7H, m), 7.22-7.07 (1H, m), 6.46 (1H, dd, *J*= 9.9, 2.1 Hz), 6.05 (1H, dd, *J*= 9.9, 2.1 Hz), 4.98 (1H, d, *J*= 10.4 Hz), 4.78 (1H, d, *J*= 11.7 Hz), 4.63 (1H, d, *J*= 11.7 Hz), 4.33 (1H, ddd, *J*= 10.4, 2.2, 2.2 Hz), 2.61 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 138.0, 135.9, 131.9, 128.5, 128.3, 128.1, 127.9, 127.9, 127.8, 127.4, 126.2, 125.1, 80.4, 72.6, 71.3. HRMS calcd for $C_{17}H_{16}O_2$ (M^+): 252.1150. Found: 252.1148.



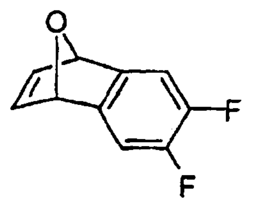
[0032] (1S,2S)-2-(4-Methoxybenzyloxy-1,2-dihydro-naphthalen-1-ol (22): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (6.0 mg, 0.012 mmol), (S),(R)-PPF-P^tBu_2 (13.0 mg, 0.024 mmol), and **13** (693 mg, 4.81 mmol) were added followed by addition of THF (1.5 mL) and anisyl alcohol (3.0 mL, 24.1 mmol) and heating to 80°C for 24 hours.. The THF was then removed *in vacuo* and the resulting oil was purified by flash chromatography (20% ethyl acetate in hexanes) to give **22** as a crystalline solid (1.18 g, 87%). The ee was determined to be 97% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 1.5% isopropanol in hexanes were 37.1 min and 42.1 min (major). R_f= 0.53 on silica gel (30% ethyl acetate:hexanes); mp 63-64° (Et_2O); $[\alpha]^{25}_D$= +138.5° (c= 10.5, $CHCl_3$); IR (KBr, cm^{-1}) 3435(br), 3035(m), 2836(s), 1612(s), 1513(s), 1454(m), 1249(s), 1082(s); ^1H NMR (400MHz, $CDCl_3$) δ 7.59-7.57 (1H, m), 7.32 (2H, ddd, *J*= 8.7,2.8, 1.9 Hz), 7.28-7.22 (1H, m),), 6.90 (2H, ddd, *J*= 8.7, 2.8, 1.9 Hz), 6.46 (1H, dd, *J*= 9.9, 2.1 Hz), 6.04 (1H, dd, *J*= 9.9, 2.4 Hz), 4.96 (1H, d, *J*= 10.1 Hz), 4.64 (1H, dd, *J*= 57.1, 11.4 Hz), 4.32 (1H, ddd, *J*= 10.2,2.2,2.2 Hz), 3.80 (1H, s), 2.96 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 159.2, 135.9, 131.9, 129.9, 129.5, 128.1, 127.8, 127.6, 127.5, 126.1, 125.0, 113.8, 80.0, 72.5, 70.9, 55.1. HRMS calcd for $C_{17}H_{16}O_2$ (M^+): 252.1150. Found: 252.1148.



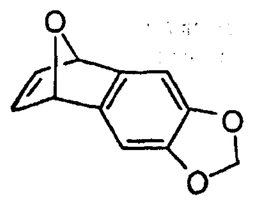
[0033] (1S,2S)-2-(2,2,2-Trifluoro-ethoxy)-1,2-dihydro-naphthaten-1-ol (17): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (2.1 mg, 0.043 mmol), (S)-(R)-PPF-P^tBu_2 (3.8 mg, 0.087 mmol) and **13** (500 mg, 3.47 mmol) were added followed by addition of trifluoroethanol (4 mL) and THF (4 mL). The mixture was heated to reflux for three hours and the solvent was removed *in vacuo*. The resulting solid was purified by flash chromatography (10% ethyl acetate in hexanes) to give **17** as a white crystalline solid (594 mg, 70%). The ee was determined to be 98% using HPLC analysis on a CHIRALCEL OD column, λ = 254 nm. Retention times in 4% isopropanol in hexanes were 11.3 min (major) and 13.3 min. R_f= 0.41 on silica gel (20% ethyl acetate:hexanes); mp 79-80° (Et_2O); $[\alpha]^{25}_D$= 145.4° (c= 12.6, $CHCl_3$); IR (KBr, cm^{-1}) 3354 (br), 3036 (w), 2939 (w), 1455 (w), 1275 (s), 1169 (s), 1050(m), 977 (m); ^1H NMR (400MHz, $CDCl_3$) δ 7.57-7.55 (1H, m), 7.30-7.23 (2H, m), 7.10-7.08 (1 H, m), 6.48 (1H, dd, *J*= 9.9, 2.0 Hz), 5.94 (1H, dd, *J*= 9.9, 2.4 Hz), 4.96 (1 H, d, *J*= 2.2 Hz), 4.38 (1H, ddd, *J*= 9.9, 2.4, 2.2 Hz), 4.03 (2H, q, J^{H-F}= 8.6 Hz), 2.55 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 135.5, 131.7, 129.2, 128.3, 128.1, 126.6, 125.9, 125.2, 122.4, 83.0, 72.8, 67.0 (q, J^{C-F}= 34.4 Hz). HRMS calcd for $C_{12}H_{11}O_2F_3$ (M^+): 244.0711. Found: 244.0720.



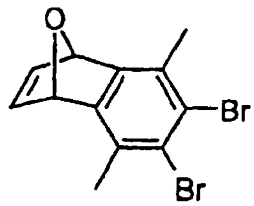
[0034] (1S,2S)-2-(2,2,2-Trifluoro-1-trifluoromethyl-ethoxy)-1,2-dihydro-naphthalen-1-ol (23): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.003 mmol),(S)-(R)-PPF-P^tBu_2 (3.8 mg, 0.007 mmol) and **13** (55 mg, 0.382 mmol) were added followed by addition of THF (2.0 mL) and hexafluoroisopropanol (240 mg, 1.74 mmol). The mixture was heated to reflux for two hours and the solvent was removed *in vacuo*. The resulting solid was purified by flash chromatography (10% ethyl acetate in hexanes) to give **23** as a white solid (107.1mg, 90%). The ee was determined to be 93% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 1.5% isopropanol in hexanes were 11.3 min and 17.6 min (major); R_f= 0.28 on silica gel (10% ethyl acetate:hexanes); mp 88.5-90° (Et_2O); $[\alpha]^{25}_D$= +101.8° (c= 10.9, $CHCl_3$); IR (KBr, cm^{-1}) 3191 (br), 2937 (m), 1379 (s), 1280 (s), 1247 (s), 1194 (s), 1100 (s), 954 (s), 753 (m); ^1H NMR (400MHz, $CDCl_3$) δ 7.55-7.53 (1H, m), 7.31-7.26 (2H, m), 7.11-7.09 (1H, m), 6.49 (1H, dd, *J*= 9.9, 2.1 Hz), 5.92 (1H, dd, *J*= 9.9, 2.4 Hz), 5.07 (1H, dd, *J*= 9.7, 5.0 Hz), 4.63 (1H, ddd, *J*= 9.9, 1.5. 1.5 Hz), 4.58 (1H, h, J^{H-F}= 6.1 Hz), 2.50 (1H, d, *J*= 4.2 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ 135.2, 131.5, 129.7, 128.5, 128.3, 126.7, 125.2, 122.9, 120.1, 85.4, 75.4 (h, J^{C-F}= 32.2 Hz), 73.5. HRMS calcd for $C_{13}H_{10}O_2F_6$ (M^+): 312.0585 Found: 312.0574.



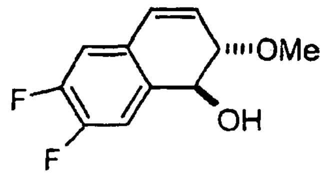
[0035] 6,7-Difluoro-1,4-epoxy-1,4-dihydronaphthalene (24). To 3,4-difluoro-1,2-dibromo-benzene (0.75 g, 2.78 mmol) and furan (1 mL, 14.7 mmol) in Et_2O (15 mL) at -78°C was added BuLi (1.1 mL, 2.5M in hexanes, 2.75 mmol) dropwise. The reaction was stirred for two hours at -78°C and then was allowed to warm to room temperature. After 2 hours, the reaction mixture was quenched with water dropwise and then was poured into water. The organic layer was separated and the aqueous layer was extracted three times with Et_2O. The combined organic layers were washed with brine, dried over $MgSO_4$, concentrated and chromatographed (25% ethyl acetate:hexanes) on silica gel to give **24** (350 mg, 70%) as a colourless oil. R_f= 0.21 on silica gel (20% ethyl acetate:hexanes); bp 40°C @ 0.5mmHg]; IR (neat, cm^{-1}), 3017 (M), 1624 (s), 1465 (s), 1365 (s), 1253 (s), 1190 (m), 1040 (s), 857 (s). ^1H NMR (400MHz, $CDCl_3$) δ 7.06 (2H, dd, J^{H-F}= 7.7, 7.7 Hz), 7.01 (2H, s), 5.67 (2H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 147.2 (dd, J^{C-F}= 247.9, 14.5 Hz), 145.1 (dd, J^{C-F}= 4.3, 4.3 Hz), 143.1, 110.8 (m), 82.1. HRMS calcd for $C_{10}H_6O$ (M^+): 180.0387. Found: 180.0394.



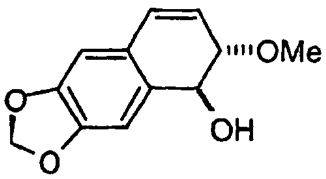
[0036] 5,8-epoxy-5,8-dihydronaphtho[2,3-d][1,3]dioxole (25): To 3,4-dibromobenzo-1,3-dioxolane (1.54 g, 5.50 mmol) and furan (4 g, 58.8 mmol) in PhMe (55 mL) at -78°C was added BuLi (2.2 mL, 2.5M in hexanes, 5.5 mmol) dropwise. The reaction was stirred for two hours at - 78°C and the allowed to warm to rt. After 3 hours, MeOH (2 mL) was added and the reaction mixture was poured into water.. The organic layer was separated and the aqueous layer was extracted three times with Et_2O. The combined organic layers were washed with brine, dried over $MgSO_4$, and concentrated. Recrystallization from hexanes gave **25** (560 mg, 54%) as white crystals). R_f= 0.47 on silica gel (30% ethyl acetate:hexanes); mp 111-112°C (Et_2O); IR (KBr, cm^{-1}) 2895, 1455, 1292, 1138, 1038, 1014, 848; ^1H NMR (400MHz, $CDCl_3$) δ 7.02 (2H, dd, J= 0.9,0.9 Hz), 6.82 (2H, s), 5.92 (1H, d, J= 1.5 Hz), 5.87 (1H, d, J= 1.5 Hz), 5.62 (2H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 144.3, 143.3, 103.9, 101.1, 82.4. HRMS calcd for $C_{11}H_8O_2$ (M^+): 188.0473. Found: 188.0463.



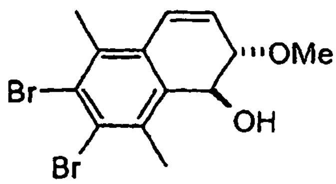
[0037] 5,6-Dibromo-4,7-dimethyl-1,4-epoxy-1,4-dihydronaphthalene (26): To tetrabromo para-xylene (2.1 g, 5.0 mmol) and furan (4 g, 58.8 mmol) in PhMe (55 mL) at -78°C was added BuLi (2.2 mL, 2.5M in hexanes, 5.5 mmol) dropwise. The reaction was stirred for two hours at -78°C and the allowed to warm to rt. After 3 hours, MeOH (2 mL) was added and the reaction mixture was poured into water.. The organic layer was separated and the aqueous layer was extracted three times with Et_2O. The combined organic layers were washed with brine, dried over $MgSO_4$, and concentrated. Flash chromatography on silca gel gave **26** (185 mg, 50%) as a white solid. The spectral data correlates well with the literature values.[22]



[0038] **(1S,2S)-6,7-Difluoro-2-methoxy-1,2-dihydro-naphthalen-1-ol (27)**: To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), (S)-(R)-PPF-P^tBu_2 (5.4 mg, 0.010mmol) and **24** (72 mg, 0.40 mmol) were added followed by addition of THF (1.0 mL) and methanol (1.0 mL). The mixture was heated to reflux for 1 hour. The solvents were then *removed in vacuo.* The resulting solid was purified by flash chromatography (20% ethyl acetate in hexanes) to give **27** as a white crystalline solid (74.9 mg, 88%). The ee was determined to be 96.4% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 4% isopropanol in hexanes were 8.9 min and 10.1 min (major). R_f= 0.27 on silica gel (30% ethyl acetate:hexanes); mp 129-131° (Et_2O); $[\alpha]^{25}_D$= +134.4° (c= 9.3, $CHCl_3$); IR (KBr, cm^{-1}) 3269 (br), 2937 (w), 1597 (m), 1503 (s), 1306 (s), 1103 (s), 893 (s); ^{1}H NMR (400MHz, $CDCl_3$) δ 7.40 (1H, ddd, J^{H-F}= 10.8, 7.8 Hz, J^{H-H}=0.6 Hz), 6.85 (1H, dd, J^{H-F}= 10.9, 7.8 Hz), 6.31 (1H, dd, J= 10.0, 2.0 Hz), 6.05 (1H, dd, J= 10.0, 2.0 Hz), 4.79 (1H, d, J= 11.0 Hz), 4.05 (1H, ddd, J= 11.0, 2.0, 2.0 Hz), 3.49 (3H, s), 2.94 (1H, d, J= 2.2 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ 151.0 (d, J^{H-F}= 12.5 Hz), 148.5 (dd, J^{H-F}= 12.5,2.9 Hz), 133.2 (dd, J^{H-F}= 5.2, 3.6 Hz), 128.9 (dd, J^{H-F}= 6.6, 4.4 Hz), 128.0(d, J^{H-F}=2.2 Hz), 126.5 (dd, J^{H-F}=2.2, 1.5 Hz), 115.1 (d, J^{H-F}= 18.3 Hz), 114.8 (d, J^{H-F}= 19.8 Hz), 82.3, 72.0, 57.0. HRMS calcd for $C_{10}H_{10}O_2F_2$ (M^+): 212.0649. Found: 212.0658.



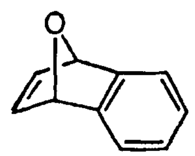
[0039] **(1S,2S)-6-Methoxy-5,6-dihydro-naphtho[2,3-d][1,3]dioxol-5-ol (28):** To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.0035 mmol), (S)-(R)-PPF-P^tBu_2 (3.8 mg, 0.0069 mmol) and **25** (100 mg, 0.694 mmol) were added followed by addition of THF (1.0 mL) and methanol (1.0 mL) and heating to reflux for 30 minutes. The solvents were then removed *in vacuo.* The resulting solid was purified by flash chromatography (30% ethyl acetate in hexanes) to give **28** as a white crystalline solid (127.5 mg, 90%). The ee was determined to be 95% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 4% isopropanol in hexanes were 19.2 min (major) and 22.6 min. R_f= 0.24 on silica (30% ethyl acetate:hexanes); mp 117-119° (Et_2O); $[\alpha]^{25}_D$= +298.7° (c= 11.1, $CHCl_3$); IR (KBr, cm^{-1}) 3248 (br), 2926 (s), 1600 (m), 1483 (s), 1260 (s), 1113 (s), 941 (s), 876 (s); ^{1}H NMR (400MHz, acetone-d) δ 7.06 (1H, s), 6.65 (1H, s), 6.35 (1H, dd, J= 10.0, 2.0 Hz), 5.94 (2H, dd, J= 9.8, 1.0 Hz), 5.91 (1H, dd, J= 10.0, 2.5 Hz), 4.72 (1H, dt, J= 9.9 Hz), 4.02 (1H, dt, J= 10.3,2.2 Hz), 3.48 (3H, s), 2.87 (1H, d, J= 13.2 Hz); ^{13}C NMR (400MHz, acetone-d) δ 147.8, 147.6, 133.0, 128.1, 127.2, 127.2, 107.5, 107.5, 101.9, 82.1, 73.0, 57.0. HRMS calcd for $C_{12}H_{12}O_4$ (M^+): 220.0736. Found: 220.0684.



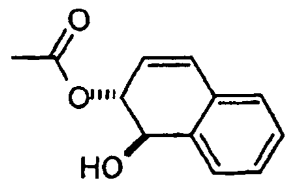
[0040] **(1S,2S)-6,7-Dibromo-2-methoxy-5,8-dimethyl-1,2-dihydro-naphthalen-1-ol (29):** To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (1.5 mg, 0.0029 mmol), (R)-(S)-PPF-P^tBu_2 (3.2 mg, 0.0059 mmol) and **26** (195 mg, 0.59 mmol) were added followed by addition of trifluoroethanol (1.0 mL) and methanol (1.0 mL). The mixture was heated to reflux for 20 hours. The solvents were then removed *in vacuo*. The resulting solid was purified by flash chromatography (50% ethyl acetate in hexanes) to give **29** as a white crystalline solid (171.6 mg, 79%). The ee was determined to be 97% using HPLC analysis on a CHIRALCEL OD column, λ = 486 nm. Retention times in 4% isopropanol in hexanes were 16.8 min (major) and 19.3 min. R_f= 0.39 on silica gel (50% ethyl acetate:hexanes); mp 114-116° (Et_2O); $[\alpha]^{25}_D$=-197.1° (c= 10.0, $CHCl_3$); IR (KBr, cm^{-1}) 3349 (s), 2901 (m), 1700 (w), 1532 (w), 1404 (m), 1258 (m), 1081 (s), 936 (s); ^1H NMR (400MHz, $CDCl_3$) δ 6.96-6.93 (1H, m), 6.23-6.19 (1H, m), 4.89 (1H, s), 3.96-3.90 (1H, m), 3.38-3.35 (3H, m), 2.61-2.57 (3H, m), 2.54 (3H, s), 1.82-1.54 (1H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 137.3, 134.4, 133.2, 129.7, 129.5, 129.0, 128.1, 125.3, 75.3, 66.6, 56.6, 21.0, 20.6. HRMS calcd for $C_{13}H_{16}O_2Br_2$ (M^+): 361.9518. Found: 361.9335.

Example 4: Compounds Formed From Reactions Involving Carboxylate Nucleophiles

[0041]

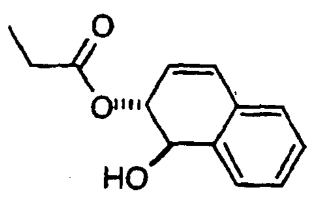


1



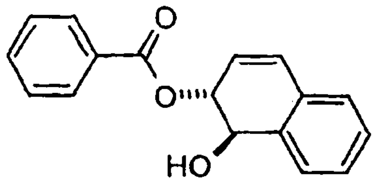
2

[0042] (1R*,2R*)-Acetic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester (2): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.008 mmol DPPF (9.6 mg, 0.017 mmol), 1 (50 mg, 1.39 mmol), and sodium acetate (142 mg, 1.74 mmol) were added followed by addition of THF (2 mL) and triethylamine hydrochloride (239 mg, 1.74 mmol). The mixture was heated at reflux for 3 hours and the solvents were removed *in vacuo*. The resulting mixture was purified by flash chromatography (30% ethyl acetate in hexanes) to give **2** as a crystalline solid (41 mg), 63%). R_f= 0.26 on silica gel (20% ethyl acetate:hexanes); mp 67-68° (Et_2O); IR (KBr, cm^{-1}) ^1H NMR (400MHz, $CDCl_3$) δ 7.54-7.53 (1H, m), 7.29-7.24 (2H, m), 7.10-7.08 (1H, m), 6.50 (1H, dd, *J*= 3.9, 1.3 Hz), 5.85 (1H, dd, *J*= 9.9, 3.1 Hz), 5.59 (1H, ddd, *J*= 9.0, 2.8, 1.9 Hz), 4.92 (1H, d, *J*=9.0 Hz), 2.64 (1H, s), 2.12 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 171.3, 135.2, 131.5, 129.5, 128.3, 126.7, 126.0, 125.4, 75.3, 71.7, 21.2. HRMS calcd for $C_{12}H_{12}O_3$ (M^+): 204.0786. Found: 204.0791.



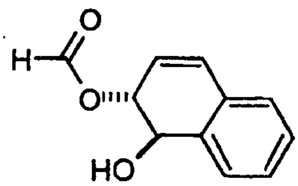
3

[0043] (1R*,2R*)-Propionic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester (3): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), DPPF (9.6 mg, 0.017 mmol) and **1** (50 mg, 0.347 mmol) were added followed by addition of THF (2.5 mL), triethylamine (242 μL, 1.735 mmol) and propionic acid (130 μL, 1.735 mmol). The mixture was heated at reflux for 3 hours and the solvents were removed *in vacuo*. The resulting mixture was purified by flash chromatography (20% ethyl acetate in hexanes) to give 3 a white crystalline solid (50 mg, 66%). R_f= 0.24 on silica gel (% 20 ethyl acetate:hexanes); mp 55-56° (Et_2O); IR (KBr, cm^{-1}) 3491 (br), 3048 (w), 2984 (w), 1739 (s), 1454 (m), 1363 (w), 1182 (s), 1083 (m). ^1H NMR (400MHz, $CDCl_3$) δ 7.55-7.52 (1H, m), 7.29-7.24 (2H, m), 7.11-7.08 (1H, m), 6.50 (1H, dd, *J*= 10.0, 2.0 Hz), 5.85 (1H, dd, *J*= 12.8, 2.8 Hz), 5.61 (1H, ddd, *J*= 9.2,2.8,2.0 Hz), 4.93 (1H, d, *J*= 9.2 Hz), 2.40 (2H, qd, *J*= 7.6, 1.2 Hz), 1.16 (3H, t, *J*= 7.6 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ 174.8, 135.3, 131.5, 129.4, 128.3, 128.3, 126.7, 125.9, 125.5, 75.2, 71.9, 27.7, 9.0. HRMS calcd $C_{13}H_{14}O_3$ (M^+): 218.0943. Found: 218.0938



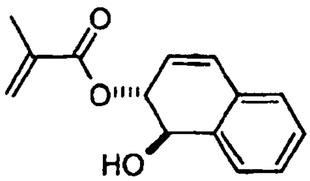
4

[0044] **(1R,2R)-Benzoic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester (4)**: To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), (R)-(S)-BPPFA (9.6 mg, 0.017 mmol) and **1** (100 mg, 0.694 mmol) were added followed by addition of THF (4 mL), triethylamine (483 μL, 3.47 mmol) and benzoic acid (424 mg, 3.47 mmol). The mixture was heated at reflux for 6 hours and the solvents were removed *in vacuo*. The resulting mixture was purified by flash chromatography (20% ethyl acetate in hexanes) to give **4** a white crystalline solid (129 mg, 70%). The ee was determined to be 76% using HPLC analysis on a CHIRALCEL OD column, 10% isopropanol in hexanes, λ=254 nm. Retention times were 10.0 min (major) and 12.9 min. R_f= 0.3 on silica gel (10% ethyl acetate:hexanes); mp 107-109° (Et_2O); $[\alpha]^{25}_D$= -298.4° (c= 11.3, $CHCl_3$); IR (KBr, cm^{-1}) 3619 (br), 3071 (w), 2977 (w), 1724 (s), 1451 (m), 1324 (m), 1265 (s), 1110 (s). ^1H NMR (400MHz, $CDCl_3$) δ 8.10 (2H, d, *J*= 7.6 Hz), 7.64-7.59 (2H, m), 7.48-7.45 (2H, m), 7.34-7.32 (2H, m), 7.13-7.11 (1H, m), 6.55 (1H, d, *J*= 10.0 Hz), 5.97 (1H, dd, *J*= 9.8, 2.9 Hz), 5.86 (1H, ddd, *J*= 9.8, 2.0, 2.0 Hz), 5.11 (1H, d, *J*= 9.0 Hz), 2.84 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 166.9, 135.3, 133.3, 131.6, 129.9, 129.8, 129.7, 128.4, 128.4, 128.4, 126.8, 126.1, 125.5, 76.1, 71.9. HRMS calcd for $C_{17}H_{14}O_3$ (M^+): 266.0943. Found: 266.0938.



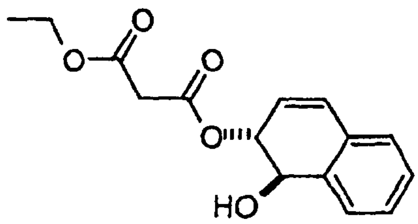
5

[0045] **(1R*,2R*)-Formic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester (5):** To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), DPPF (9.6 mg, 0.017 mmol), **1** (100 mg, 0.694 mmol), and ammonium formate (219 mg, 3.47 mmol), were added followed by addition of THF (5 mL). The mixture was heated at reflux for 3 hours and the solvents were removed *in vacuo*. The resulting mixture was purified by flash chromatography (30% ethyl acetate in hexanes) to give **5** a white crystalline solid (84 mg, 64%). R_f= 0.25 on silica gel (30% ethyl acetate:hexanes); mp 133-135° (Et_2O); IR (KBr, cm^{-1}) 3146 (br), 2935 (w), 1720 (s), 1482 (w), 1186 (s), 1049 (m), 968 (m); ^1H NMR (400MHz, $CDCl_3$) δ 8.17 (1H, d, *J*= 0.8 Hz), 7.52-7.50 (1H, m), 7.29-7.27 (2H, m), 7.13-7.11 (1H, m), 6.54 (1H, dd, *J*= 9.6, 1.6 Hz), 5.88 (1H, dd, *J*= 9.6, 2.8 Hz), 5.71-5.68 (1H, m), 4.96 (1H, d, *J*= 8.8 Hz), 2.8 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 160.9, 134.8, 131.4, 130.0, 128.5, 126.9, 126.1, 124.6, 74.8, 71.4. HRMS calcd for $C_{11}H_{10}O_3$ (M^+): 190.0630. Found: 190.0625.



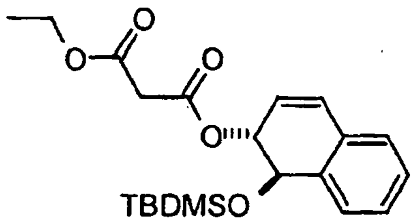
6

[0046] **(1R*,2R*)-2-Methyl acrylic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester (6)**: To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), DPPF (9.6 mg, 0.017 mmol) and 1 (50 mg, 0.347 mmol) were added followed by addition of THF (2.5 mL), triethylamine (242 μL, 1.735 mmol) and methacrylic acid (147 μL, 1.735 mmol). The mixture was heated at reflux for 3 hours and the solvents were removed *in vacuo*. The resulting mixture was purified by flash chromatography (30% ethyl acetate in hexanes) to give 6 a white crystalline solid (50 mg, 63%). R_f= 0.32 on silica gel (20% ethyl acetate:hexanes); mp 80-82° (Et_2O); IR (KBr, cm^{-1}) 3450 (br), 3030 (w), 2928 (w), 1722 (s), 1637 (m), 1454 (m), 1289 (m), 1163 (s); ^1H NMR (400MHz, $CDCl_3$) δ 7.56-7.55 (1H, m), 7.29-7.24 (2H, m), 7.10-7.09 (1H, m), 6.51 (1H, dd, *J*= 9.9, 1.9 Hz), 6.15 (1H, s), 5.87 (1H, dd, *J*= 9.9, 3.0 Hz), 5.67 (1H, ddd, *J*= 9.3, 2.1, 2.1 Hz), 5.61 (1H, s), 5.01 (1H, dd, *J*= 9.0, 5.7 Hz), 2.74 (1H, d, *J*= 6.1 Hz), 1.96 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 167.6, 135.9, 135.3, 131.5, 129.4, 128.3, 128.2, 126.6, 126.4, 125.8, 125.5, 75.9, 71.9, 18.3.. HRMS calcd $C_{14}H_{12}O_2$ (M^+-H_2O): 212.0837. Found: 212.0831



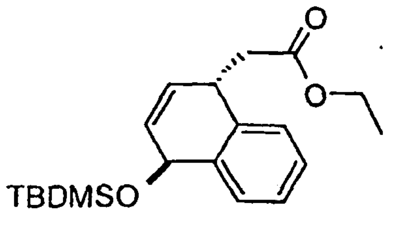
7

[0047] (1R*,2R*)-Malonic acid ethyl ester (1-hydroxy-1,2-dihydro-naphthalen-2-yl) ester (7): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (8.6 mg, 0.017 mmol DPPF (19.2 mg, 0.035 mmol), **1** (200 mg, 1.39 mmol), ethyl malonate potassium salt (590 mg, 3.47 mmol), and triethylamine hydrochloride (478 mg, 3.47 mmol) were added followed by addition of THF (8 mL). The mixture was heated at reflux for 3 hours and the solvents were removed *in vacuo*. The resulting mixture was purified by flash chromatography (30% ethyl acetate in hexanes) to give **7** a colourless oil (300 mg), 79%). R_f= 0.29 on silica gel (30% ethyl acetate:hexanes); IR (KBr, cm^{-1}) 3470 (br), 2983 (w), 1731 (s), 1453 (w), 1370 (m), 1150 (s), 1031 (m); ^1H NMR (400MHz, $CDCl_3$) δ 7.56-7.54 (1H, m), 7.27-7.21 (2H, m), 7.08-7.06 (1H, m), 6.48 (1H, dd, *J*= 9.9, 2.1 Hz), 5.83 (1H, dd, *J*= 9.7, 2.8 Hz), 5.70 (1 H, ddd, *J*= 9.7, 2.5, 2.2 Hz), 4.97 (1H, d, *J*= 9.5 Hz), 4.18 (2H, q, *J*= 7.2 Hz), 3.43 (2H, dd, *J*= 23.6, 15.9 Hz), 3.21 (1H, s), 1.25 (3H, t, *J*= 7.1 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ 167.1, 166.5, 135.0, 131.5, 129.6, 128.3, 128.1, 126.6, 125.6, 125.1, 77.0, 71.6, 61.9, 41.6, 14.0. HRMS calcd for $C_{15}H_{14}O_4$ (M^+-H_2O): 258.0892. Found: 258.0899.



8

[0048] (1R*,2R*)-Malonic acid (1-tert-butyldimethylsiloxy-1,2-dihydro-naphthalen-2-yl) ester ethyl ester (8): To a dried round bottom flask, 7 (270 mg, 0.98 mmol), imidazole (134 mg, 1.96 mmol), dimethylaminopyridine (6 mg, 0.05 mmol) were dissolved in dichloromethane (4 mL). Tert-butyldimethylsilyl chloride (222 mg, 1.47 mmol) was then added portionwise and allowed to react for 24 hours. The reaction was then quenched with water, extracted with dichloromethane, dried over Na_2SO_4 and concentrated *in vacuo*. Flash chromatography (10% ethyl acetate in hexanes) gave a colourless oil **8** (343 mg, 90%). R_f= 0.48 on silica gel (10% ethyl acetate:hexanes. IR (KBr, cm-1) 2983 (w), 1731 (s), 1453 (w), 1370 (m), 1150 (s), 1031 (m); ^1H NMR (400MHz, $CDCl_3$) δ 7.41-7.39 (1H, m), 7.24-7.22 (2H, m), 7.07-7.05 (1H, m), 6.47 (1H, dd, *J*= 9.9, 1.8 Hz), 5.83 (1H, dd, *J*= 9.7, 2.7 Hz), 5.60 (1H, ddd, *J*= 9.3, 2.9, 2.0 Hz), 5.00 (1H, *dd*, *J*= 9.3, 0.5 Hz), 4.22-4.15 (2H, m), 3.40 (2H, dd, *J*= 19.6, 16.0 Hz), 1.57 (1H, s), 1.25 (3H, t, *J*= 7.1 Hz), 0.92 (9H, s), 0.13 (3H, s), 0.09 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 166.3, 166.2, 136.2, 132.1, 129.4, 128.0, 127.9, 126.5, 125.9, 125.7, 76.4, 71.6, 61.6, 41.7, 25.8, 18.1, 14.0, -4.3, -4.5. HRMS calcd for $C_{17}H_{21}O_5Si$ (M^+-C_4H_9): 333.1158. Found: 333.1149.

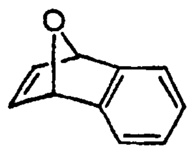


9

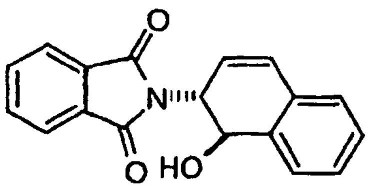
[0049] (1S*,2S*)-(4-Tert-butyldimethylsiloxy-1,4-dihydro-naphthalen-2-yl) acetic acid ethyl ester (9): To a dried round bottom flask, **8** (100 mg, 0.256 mmol) was dissolved in THF (4 mL). Potassium hydride (11.3 mg, 0.28 mmol) was then added portionwise and allowed to react for five minutes at room temperature. Triphenylphosphine (34.1 mg, 0.13 mmol) was then added followed by $Pd(PPh_3)_4$ (14.8 mg, 0.013 mmol). The reaction was then heated to reflux for two hours. The solvent was then removed *in vacuo* and the resulting oil purified by flash chromatography (5% ethyl acetate in hexanes) giving **9** a colourless oil (54 mg, 61%). R_f= 0.27 on silica gel (5% ethyl acetate:hexanes); IR (KBr, cm^{-1}) 3036(w), 2956(s), 1735(s), 1472(m), 1257(s), 1077(s); ^1H NMR (400MHz, $CDCl_3$) δ 7.54-7.52 (1H, m), 7.30-7.23 (3H, m), 6.09 (1H, ddd, *J*= 2.4, 4.6, 10.2 Hz), 6.02 (1H, ddd, *J*= 10.2, 2.0, 0.5 Hz), 5.22-5.21 (1H, m), 4.15 (2H, q, *J*= 7.2 Hz), 3.92-3.87 (1H, m), 2.62 (1H, dd, *J*= 15.7,5.7 Hz), 2.39 (1H, dd, *J*= 15.2, 9.0 Hz), 1.25 (3H, t, *J*= 7.2 Hz), 0.98 (9H, s), 0.21 (3H, s), 0.15 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 171.7, 138.3, 136.1, 131.8, 128.2, 127.2, 127.0, 126.9, 126.6, 65.3, 60.5, 42.7, 36.5, 25.9, 18.2, 14.2, -4.2, -4.5. HRMS calcd $C_{17}H_{21}O_5Si$ (M^+-C_4H_9): 289.1260. Found: 289.1257

Example 5: Compounds Formed In Reactions Involving Nitrogen Nucleophiles

[0050]



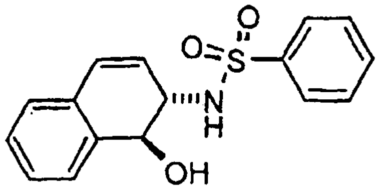
1



2

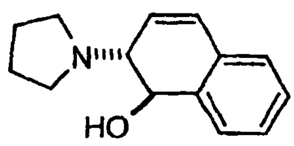
[0051] (1R,2R)-2-(1-hydroxy-1,2-dihydro-naphthalen-2-yl)-isoindole-1,3-dione (2): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (5.4mg, 0.011 mmol), (R)-(S)-BPPFA (12.2 mg, 0.022 mmol), phthalimide (510 mg, 3.47 mmol) and **1** (100 mg, 0.69 mmol) were added. THF (4 mL) was then added, followed by heating to 80°C for 3 days. The reaction mixture was then poured in to water and extracted three times with ethyl acetate. The organic layers were combined, washed with brine dried over Na_2SO_4, and concentrated *in vacuo*. The resulting solid was purified by flash chromatography (30% ethyl acetate in hexanes) to give **2** as a white crystalline solid (103.5 mg, 52%). The ee was determined to be 74% using HPLC analysis on a CHIRALCEL OD column, λ= 486nm. Retention times in 10% isopropanol in hexanes were 21.1 min (major)and 29.1 min. R_f= 0.36 on silica gel (30% ethyl acetate:hexanes); mp 175-176° (dec); $[\alpha]^{25}_D$= -6.1° (c= 12.9, $CHCl_3$); IR (KBr, cm^{-1}) 3536 (br), 3067 (w), 2921 (w), 1772 (m), 1693 (s), 1388 (s), 1084 (m), 955 (m), 719 (s); ^1H NMR (400MHz, $CDCl_3$) δ 7.78-7.75 (2H, m), 7.68-7.64 (2H, m), 7.57-7.55 (1H, m), 7.26-7.22 (2H, m), 7.09-7.07 (1H, m), 6.51 (1H, dd, J= 9.7, 2.7 Hz), 5.84 (1H, ddd, *J*= 9.7, 2.7, 2.2 Hz), 5.48 (1H, d, *J*= 12.8 Hz), 5.12 (1H, ddd, *J*= 12.8, 2.5, 2.4 Hz), 2.82 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 168.6, 137.3, 134.2, 132.6, 132.1, 128.7, 128.2, 128.1, 126.9, 126.5, 124.4, 123.5, 70.9, 55.3. HRMS calcd for $C_{18}H_{11}NO_2$ (M^+-H_2O): 273.2939. Found:

273.0793.



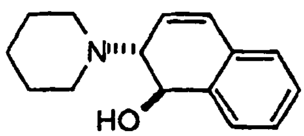
3

[0052] (1S,2S)-N-(1-Hydroxy-1,2-dihydro-naphthalen-2-yl)-benzene sulfonamide (3): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), (S)-(R)-PPF-P^tBu_2 (9.4 mg, 0.0173 mmol), benzenesulfonamide (545 mg, 3.47 mmol) and **1** (100 mg, 0.69 mmol) were added. THF (2 mL) was then added, followed by heating to 80°C for 12 hours. The reaction mixture was then poured into water and extracted three times with ethyl acetate. The organic layers were combined, washed with brine dried over Na_2SO_4, and concentrated *in vacuo*. The resulting solid was purified by flash chromatography (30% ethyl acetate in hexanes) to give **3** a white crystalline solid (223 mg, 96%). The ee was determined to be 95% by Mosher's ester formation and HPLC analysis on a CHIRALCEL OD column, λ= 486nm. Retention times in 10% isopropanol in hexanes were 26.6 min (major) and 39.4 min. R_f= 0.22 on silica gel (30% ethyl acetate:hexanes); mp 128-130° (dec); $[\alpha]^{25}{}_D$= 70° (c= 8.3, $CHCl_3$); IR (KBr, cm^{-1}) 3462 (br), 3200 (m), 2957 (w), 1447 (m); 1329 (m), 1329 (m), 1164 (s), 1093 (m). ^1H NMR (400MHz, $CDCl_3$) δ 7.91-7.90 (2H, m), 7.62-7.58 (1H, m), 7.54-7.50 (2H, m), 7.47-7.45 (1H, m), 7.27-7.23 (2H, m), 6.40 (1 H, dd, *J*= 9.7, 1.7 Hz), 5.55 (1H, dd, *J*= 9.7, 3.1 Hz), 5.26 (1H, s), 4.77 (1H, d, *J*= 8.8 Hz), 4.13-4.07 (1H, m), 2.91 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 140.2, 134.9, 132.9, 131.3, 129.5, 129.2, 128.4, 128.4, 127.1, 126.4, 126.0, 72.0, 56.3. HRMS calcd for $C_{16}H_{15}NO_3S$ (M^+): 301.0773. Found: 301.0769.



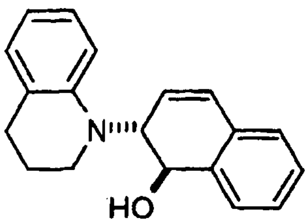
4

[0053] (1R*,2R*)-2-Pyrrolidin-1-yl-1,2-dihydro-naphthalen-1-ol (4): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3mg, 0.009 mmol), DPPF (9.6 mg, 0.017 mmol), pyrrolidine (146 mg, 3.47 mmol), triethylamine hydrochloride (478 mg, 3.47 mmol) and **1** (125 mg, 0.865 mmol) followed by addition of THF (3 mL) and heating to reflux for 8 hours. The solvent was then removed *in vacuo* and the resulting mixture purified by flash chromatography (10% methanol in acetone) to give **4** a white crystalline solid (119 mg, 80%). R_f= 0.14 on silica gel (10% methanol in acetone); mp 97-98° (Et_2O); IR (KBr, cm^{-1}) 3496 (br), 3035 (m), 2967 (s), 1454 (m), 1193 (s), 1117 (m), 1048 (s). ^1H NMR (400MHz, $CDCl_3$) δ 7.56 (1H, d, *J*= 7.1 Hz), 7.29-7.21 (2H, m), 7.08-7.06 (1H, m), 6.57 (1H, dd, *J*= 9.9, 2.4 Hz), 6.05 (1H, dd, *J*= 9.9, 2.4 Hz), 4.83 (1H, d, *J*= 11.3 Hz), 3.66 (1H, ddd, *J*= 11.3, 2.4, 2.4 Hz), 3.5 7 (1H, s), 2.81-2.79 (2H, m), 2.73-2.71 (2H, m), 1.84-1.80 (4H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 136.9, 131.8, 129.6, 127.7, 127.3, 126.1, 125.4, 124.7, 69.8, 63.3, 48.7, 23.8. HRMS calcd for $C_{14}H_{17}NO$ (M^+): 215.1310.. Found: 215.1314.



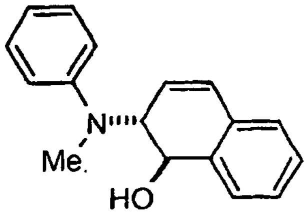
5

[0054] **(1R*,2R*)-2-Piperidin-1-yl-1,2-dihydro-naphthalen-1-ol:** To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), DPPF (9.6 mg, 0.0173 mmol), piperidine hydrochloride (422 mg, 3.47 mmol), triethylamine (350 μL, 2.51 mmol) and 1 (100 mg, 0.69 mmol) were added followed by THF (3 mL) and heating to 80°C for 12 hours. The reaction mixture was then concentrated *in vacuo* and purified by flash chromatography (50% ethyl acetate, 48% hexanes, 2% methanol) to give 5 a white crystalline solid (130 mg, 82%). R_f= 0.24 on silica gel (50% ethyl acetate, 48% hexanes, 2% methanol); mp 62-64° (Et_2O); IR (KBr, cm^{-1}) 3482 (br), 3036 (w), 2937 (s), 2853 (m), 1453 (s), 1193 (s), 1109 (s), 1046 (s). ^1H NMR (400MHz, $CDCl_3$) δ 7.57 (1H, d, *J*= 7.1 Hz), 7.27-7.18 (2H, m), 7.05 (1H, dd, *J*= 6.9, 0.9 Hz), 6.49 (1H, dd, *J*= 9.9, 2.6 Hz), 6.12 (1H, dd, *J*= 9.9, 2.4 Hz), 4.87 (1H, d, *J*= 12.2 Hz), 3.58 (1H, s), 3.37 (1H, ddd, *J*= 12.2, 2.4, 2.4 Hz), 2.79-2.73 (2H, m), 2.48 (2H, m), 1.67-1.57 (4H, m), 1.56-1.46 (2H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 137.4, 131.8, 128.8, 127.1, 125.9, 125.2, 124.4, 68.2, 67.6, 50.4, 26.5, 24.6. HRMS calcd for $C_{15}H_{18}NO$ (M^+-H): 228.1388. Found: 228.1318.



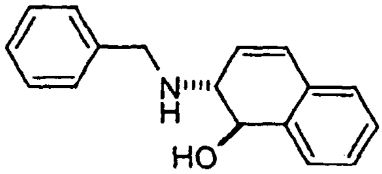
6

[0055] **(1R,2R)-2-(3,4-Dihydro-2H-quinolin-1-yl)-1,2-dihydro-naphthalen-1-ol:** To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.0087 mmol), (R)-(S)-BPPFA (9.6 mg, 0.0173 mmol), tetrahydroisoquinoline (231 mg, 1.735 mmol), 1 (60 mg, 0.416 mmol) and THF (2.5 mL) were added followed by heating to reflux for 3 hours. The solvent was then removed *in vacuo* and the resulting oil purified by flash chromatography (5% ethyl acetate in hexanes) to give **6** a colourless oil (114.1 mg, 98%). The ee was determined to be 65% using HPLC analysis on a CHIRALCEL OD column, λ= 254nm. Retention times in 10% isopropanol in hexanes were 10.3 min (major) and 11.2 min. R_f= 0.30 on silica gel (10% ethyl acetate:hexanes); $[\alpha]^{25}_D$= -30.0° (c= 13.8, $CHCl_3$); IR (KBr, cm^{-1}) 3588 (br), 3037 (w), 2932 (w), 1601 (s), 1495 (m), 1190 (m). ^1H NMR (400MHz, $CDCl_3$) δ 7.54-7.52 (1H, m), 7.31-7.29 (2H, m), 7.17-7.14 (1H, m), 7.10-7.09 (1H, m), 7.06-7.04 (1H, m), 6.94-6.93 (1H, m), 6.68-6-67 (1H, m), 6.65 (1H, dd, *J*= 9.4, 2.2 Hz), 5.96 (1H, dd, *J*= 9.9, 3.3 Hz), 5.13 (1H, d, *J*= 8.8 Hz), 4.78 (1H, ddd, *J*= 8.8, 2.5, 2.5 Hz), 3.31-3.26 (1H, m), 3.14-3.08 (1H, m), 2.81-2.80 (2H, m), 2.30 (1H, s), 1.95-1.89 (2H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 145.1, 136.5, 131.9, 129.7, 129.5, 128.0, 128.0, 128.0, 127.9, 127.0, 126.5, 125.9, 124.0, 116.8, 112.2, 69.5, 60.9, 44.1, 28.1, 22.5. HRMS calcd for $C_{19}H_{19}NO$ (M^+): 277.1467. Found: 277.1463.



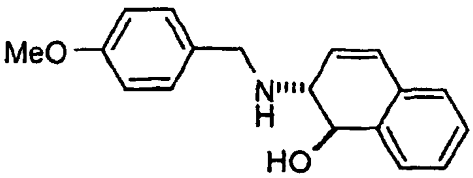
7

[0056] **(1R,2R)-2-(Methyl-phenyl-amino)-1,2-dihydro-naphthalen-1-ol (7):** To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (3.5 mg, 0.007 mmol), (R)-(S)-BPPFA (7.7 mg, 0.014 mmol), N-methylaniline (372 mg, 3.47 mmol), 1 (105 mg, 0.728 mmol) and THF (3 mL) were added followed by heating to reflux for 3 hours. The solvent was then removed *in vacuo* and the resulting oil purified by flash chromatography (5% ethyl acetate in hexanes) to give **7** a white crystalline solid (176.3 mg, 96%). The ee was determined to be 74% using HPLC analysis on a CHIRALCEL OD column, λ= 254nm. Retention times in 10% isopropanol in hexanes were 11.1 min (major) and 13.3 min. R_f= 0.41 on silica gel (20% ethyl acetate:hexanes); mp 55-56° (Et_2O); $[\alpha]^{25}_D$= 50.4° (c= 11.8, $CHCl_3$); IR (KBr, cm^{-1}) 3594 (br), 3037 (m), 2884 (m), 1596 (s), 1503 (s), 1463 (m), 1186(m), 935 (m). ^{1}H NMR (400MHz, $CDCl_3$) δ 7.57-7.55 (1H, m), 7.31-7.26 (4H, m), 7.15-7.13 (1H, m), 6.99-6.97 (2H, m), 6.84-6.81 (1H, m), 6.61 (1H, dd, J= 9.8, 2.6 Hz), 5.94 (1H, dd, J= 9.7, 2.9 Hz), 5.11 (1H, d, J= 9.8 Hz), 4.76 (1H, ddd, J= 9.7, 2.6, 2.6 Hz), 2.85 (3H, s), 2.50 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 150.1, 136.4, 131.9, 129.6, 129.2, 128.0, 127.8, 127.7, 126.4, 125.5, 118.0, 114.5, 70.0, 63.3, 33.3. HRMS calcd for $C_{17}H_{17}NO$ (M^+): 251.1310. Found: 251.1307.



8

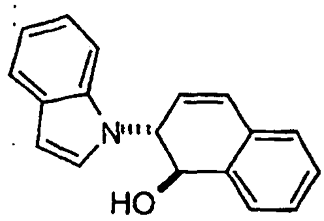
(1R*,2R*)-2-Benzylamino-1,2-dihydro-naphthalen-1-ol (8): To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.009 mmol), DPPF (9.6 mg, 0.017 mmol), benzylamine hydrochloride (279 mg, 1.74 mmol), triethylamine (242 µL, 1.74 mmol) and **1** (50 mg, 0.347 mmol) followed by addition of THF (3 mL) and heating to reflux for 3 days. The solvent was then removed *in vacuo* and the resulting mixture purified by flash chromatography (50% ethyl acetate in hexanes) to give **8** a white crystalline solid (26.9 mg, 31 %). R_f= 0.44 on silica gel (50% ethyl acetate, 48% hexanes, 2% methanol); mp 115-117° (dec) (Et_2O); IR (KBr, cm^{-1}) 3528 (br), 3030 (w), 2849 (w), 1455 (s), 1190 (m), 1112 (m), 1048 (m). ^{1}H NMR (400MHz, $CDCl_3$) δ 7.47-7.45 (1H, m), 7.29-7.24 (4H, m), 7.24-7.17 (3H, m), 7.02-7.01 (1H, m), 6.41 (1H, dd, J= 9.7, 2.0 Hz), 6.00 (1H, dd, J= 9.7, 2.5 Hz), 4.64 (1H, d, J= 9.0 Hz), 3.94 (1 H, AB, J= 13.0 Hz), 3.75 (1H, AB, J=13.0 Hz), 3.42 (1H, ddd, J= 11.0, 2.4, 2.4 Hz), 2.44 (1 H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 139.8, 136.6, 132.1, 128.8, 128.5, 128.2, 127.9, 127.8, 127.6, 127.2, 126.1, 124.9, 72.1, 59.7, 50.7. HRMS calcd for $C_{17}H_{17}NO$ (M^+): 251.1310. Found: 251.1316.



9

(1R*,2R*)-2-(4-Methoxy-benzylamino)-1,2-dihydro-naphthalen-1-ol (9): To a flame dried round bottom flask, [Rh (COD)Cl]$_2$ (4.3mg, 0.009 mmol), DPPF (9.6 mg, 0.017 mmol), p-methoxybenzylamine (238 mg, 1.74 mmol), triethylamine hydrochloride (239 mg, 1.74 mmol) and 1 (50 mg, 0.728 mmol) followed by addition of THF (3 mL) and heating to reflux for 3 days. The solvent was then removed *in vacuo* and the resulting mixture purified by flash chromatography (50% ethyl acetate in hexanes) to give **9** a white crystalline solid (43 mg, 44%).

[0057] R_f= 0.27 on silica gel (50% ethyl acetate, 48% hexanes, 2% methanol); mp 96-98° (dec) (Et_2O); IR (KBr, cm^{-1}) 3528 (br), 3033 (w), 2835 (m), 1612 (m), 1512 (s), 1455 (m), 1248 (s), 1040 (m). ^{1}H NMR (400MHz, $CDCl_3$) δ 7.52-7.50 (1H, m), 7.26-7.22 (4H, m), 7.08-7.06 (1H, m), 6.85 (2H, d, J= 9.0 Hz), 6.47 (1H, dd, J= 9.7, 2.0 Hz), 6.05 (1H, dd, J= 9.9, 2.6 Hz), 4.68 (1H, d, J= 11.0 Hz), 3.95 (1H, d, J= 12.9 Hz), 3.79 (3H, s), 3.75 (1H, d, J= 2.9 Hz), 3.46 (1H, ddd, J= 11.0, 2.4, 2.4 Hz), 3.0-2.0 (2H, s (br)); ^{13}C NMR (400MHz, $CDCl_3$) δ 158.7, 136.7, 132.1, 131.9, 129.4, 128.9, 127.9, 127.7, 127.5, 126.0, 124.9, 113.9, 72.1, 59.6, 55.2, 50.1. HRMS calcd for $C_{18}H_{19}NO_2$ (M^+): 281.1416. Found: 281.1403.

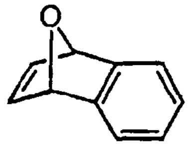


10

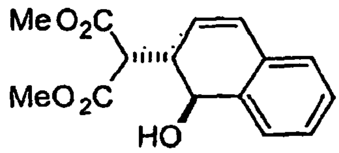
[0058] **(1R,2R)-2-Indol-1-yl-1,2-dihydro-naphthalen-1-ol (10)**: To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (4.3 mg, 0.009 mmol), (R)-(S)-BPPFA (9.6 mg, 0.017 mmol), indole (407 mg, 3.47 mmol) and 1 (100 mg, 0.69 mmol) were added. THF (4 mL) was then added, followed by heating to 80°C for 3 days. The reaction mixture was then concentrated *in vacuo*. The resulting oil was purified by flash chromatography (30% ethyl acetate in hexanes) to give **10** a colourless oil (147 mg, 81%). The ee was determined to be 79% using HPLC analysis on a CHIRALCEL OD column, λ= 254nm. Retention times in 10% isopropanol in hexanes were 28.5 min (major) and 30.1 min. R_f= 0.26 on silica gel (30% ethyl acetate:hexanes); $[\alpha]^{25}_D$= -46.7° (c= 11.3, $CHCl_3$); IR (KBr, cm^{-1}) 3485 (br), 3059 (m), 1592 (m), 1455 (s), 1414 (s), 1245 (m), 1091 (m), 908 (m); ^1H NMR (400MHz, $CDCl_3$) δ 8.13 (1H, s), 7.79 (1H, d, *J*= 7.8 Hz), 7.42 (1H, d, *J*= 7.3 Hz), 7.34-7.19 (6H, m), 6.85 (1H, d, *J*= 2.2 Hz), 6.69 (1H, dd, *J*= 9.5, 2.0 Hz), 6.20 (1H, dd, *J*= 9.5, 3.8 Hz), 5.06 (1H, d, *J*= 7.9 Hz), 4.12-4.08 (1H, m), 2.35 (1H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 136.5, 135.9, 132.5, 130.1, 128.0, 127.7, 126.9, 126.5, 126.4, 126.2, 122.6, 122.0, 119.3, 119.2, 113.9, 111.4, 72.7, 41.0. HRMS calcd for $C_{18}H_{15}NO$ (M^+): 261.1154. Found: 261.1141.

Example 6: Compounds Formed In Reactions Involving Carbon Nucleophiles

[0059]



1

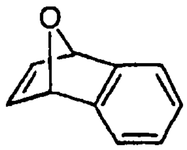


2

[0060] **(1S*,2R*)-2-(Hydroxy-1,2-dihydro-naphthalen-2-yl)malonic acid dimethyl ester (2)**: To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (8.6 mg, 0.0174 mmol), DPPF (19.2 mg, 0.0347 mmol), dimethyl malonate (137 mg, 1.041 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (1.5 mL) and heating to 80°C for 24 hours. The reaction mixture was then poured in to water and extracted three times with ethyl acetate. The organic layers were combined, washed with brine dried over Na_2SO_4, and concentrated *in vacuo*. The resulting oil was purified by flash chromatography (20% ethyl acetate in hexanes then increasing to 50% ethyl acetate in hexanes) to give **2** a colourless oil which crystallized on sitting (124.3 mg, 65%). R_f= 0.27 on silica gel (50% ethyl acetate:hexanes); mp 65-67° (Et_2O); IR (neat, cm^{-1}) 3490 (br), 3024 (m), 2954 (s), 1744 (s), 1436 (s), 1159 (s), 1026 (s), 913 (m), 783 (s); ^1H NMR (400MHz, $CDCl_3$) δ 7.40-7.38 (1H, m), 7.30-7.24 (2H, m), 7.13-7.11 (1H, m), 6.57 (1H, dd, *J*= 9.7, 1.5 Hz), 5.97 (1H, dd, *J*= 9.7, 4.2 Hz), 4.70 (1H, dd, *J*= 6.2, 6.2 Hz), 3.73 (3H, s), 3.70 (3H, s), 3.52 (1H, d, *J*= 7.6 Hz), 3.37-3.35 (1H, m), 2.09 (1H, d, *J*= 6.2 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ 168.6, 168.3, 135.4, 131.9, 128.3, 128.1, 126.8, 126.7, 70.3, 52.6, 52.6, 52.5, 42.3. HRMS calcd for $C_{15}H_{16}O_5$ (M^+): 276.0998. Found: 276.0104.

Example 7: Compounds Formed In Reactions Involving Phenol Nucleophiles

[0061]



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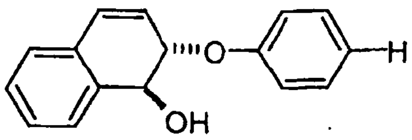
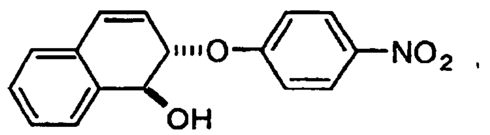


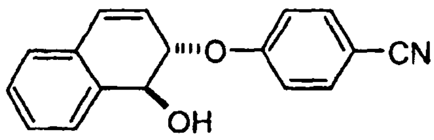
2

[0062] **(1S,2S)-2-Phenoxy-1,2-dihydro-naphthalen-1-ol (2)**: To a flame dried round bottom flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^tBu_2 (3.8 mg, 0.0069 mmol, and 1 (100 mg, 0.694 mmol) were added. THF (2 mL) and phenol (327 mg, 3.47 mmol) were then added followed by heating to 80°C for 1.5 hours. The reaction mixture was then poured in to ether and washed three times with 5% aqueous Noah. The aqueous layers were combined and back extracted three times with ether. The organic layers were combined, washed with brine, dried over Na_2SO_4, and concentrated *in vacuo.* The resulting solid was purified by flash chromatography (20% ethyl acetate in hexanes) to give **2** as a white crystalline solid (130.7 mg, 83%). The ee was determined to be 99.2% using HPLC analysis on a CHIRALCEL OD column, λ= 486 nm. Retention times in 4% isopropanol in hexanes were 15.2 min (major) and 17.8 min. F_r= 0.26 on silica gel (10% ethyl acetate:hexanes); mp 109-110°C (Et_2O); $[\alpha]^{25}{}_D$= +204.7° (c= 10.1, $CHCl_3$); IR (KBr, cm^{-1}) 3337 (br), 3029 (w), 2866 (w), 1600 (m), 1496 (s), 1249 (s), 1062 (s); ^1H NMR (400 MHz, $CDCl_3$) δ 7.65-7.63 (1H, m), 7.33-7.25 (4H, m), 7.13-7.11 (1H, m), 7.01-6.95 (3H, m), 6.51 (1H, dd, *J*= 9.9, 1.6 Hz), 6.02 (1H, dd, *J*= 9.9, 2.2 Hz), 5.19 (1H, d, *J*= 10.4 Hz), 5.11 (1H, ddd, *J*= 10.4, 2.0, 2.0 Hz), 2.66 (1H, s); ^{13}C NMR (400 MHz, $CDCl_3$) δ 157.4, 135.5, 131.9, 129.7, 129.0, 128.2, 128.0, 126.4, 126.1, 125.2, 121.5, 115.9, 79.1, 72.4. HRMS calcd for $C_{16}H_{14}O_2$ (M^+): 238.0994. Found: 238.0984.



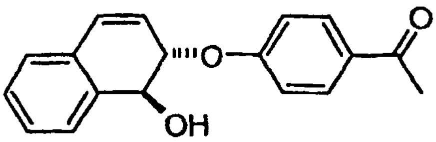
3

[0063] **(1S,2S)-2-(4-nitrophenoxy)-1,2,-dihydro-naphthalen-1-ol (3)**: To a flame dried round-bottomed flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.0035 mmol), (S)-(R)-PPF-P^tBu_2 (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-nitrophenol (483 mg, 3.47 mmol). The mixture was heated at 80°C for 45 minutes, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (30% ethyl acetate in hexanes) giving a white crystalline solid **3** (184 mg, 94%). The ee was determined to be 97% by formation of Mosher's ester. F_r = 0.43 on silica (30% ethyl acetate:hexanes); mp 123-125°C (dec.); $[\alpha]^{25}{}_D$ = +169.9° (c = 10.3, $CHCl_3$); IR (KBr, cm^{-1}) 3351 (br), 3113 (w), 3071 (w), 2884 (w), 2843 (w), 1591 (s), 1503 (s), 1342 (s), 1295 (m), 1110 (m), 896 (w); ^1H NMR (400 MHz, $CDCl_3$): δ 8.18 (2H, d, *J*=9.2 Hz), 7.62-7.60 (1H, m), 7.31-7.29 (2H, m), 7.15-7.13 (1H, m), 6.99 (2H, d, *J*= 9.2 Hz), 6.57 (1H, d, *J*= 9.9 Hz), 5.94 (1H, d, *J*= 9.9 Hz), 5.20 (2H, s), 2.61 (1H, s); ^{13}C NMR (400 MHz, $CDCl_3$): δ 162.6, 141.8, 135.0, 131.5, 130.2, 128.5, 128.4, 126.8, 126.0, 125.5, 124.1, 115.4,79.6,72.0.



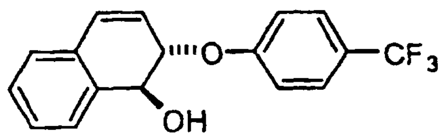
4

[0064] (1S,2S)-2-(4-Cyanophenoxy)-1,2,-dihydro-naphthalen-1-ol (4): To a flame dried round-bottomed flask, [Rh (COD)Cl]$_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^{t}Bu$_2$ (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-cyanophenol (413 mg, 3.47 mmol). The mixture was heated at 80°C for 5 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (30% ethyl acetate in hexanes) giving a white crystalline solid **4** (160 mg, 88%). The ee was determined to be 97% by HPLC analysis on a CHIRALCEL OD column, λ= 256 nm. Retention times in 3% isopropanol in hexanes were 35.3 min and 37.7 min (major). F_r = 0.40 on silica (30% ethyl acetate in hexanes); mp 140-141°C (Et_2O); $[\alpha]^{25}_D$ = +182.3° (c = 11.2, $CHCl_3$) IR (KBr, cm^{-1}) 3303 (b) 3050 (w) 2210 (m) 1598 (s) 1503 (s) 1238 (s) 1025 (m) 859 (m) 778 (m); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.62-7.57 (3H, m), 7.33-7.27 (3H, m), 7.14-7.12 (1H, m), 6.56 (1H, dd, *J*= 1.4, 9.7 Hz), 5.93 (1H, dd, *J*= 1.4,9.7 Hz), 5.20-5.13 (2H, m), 2.25 (1H, s). ^{13}C NMR (400 MHz, $CDCl_3$): δ 160.8, 135.0, 134.2, 131.5, 130.0, 128.5, 128.3, 126.7, 125.4, 124.4, 119.0, 116.2, 104.6, 79.2, 72.0. HRMS calcd for $(M-H_2O)^+$ ($C_{17}H_{11}ON$): 245.0841. Found: 245.0845.



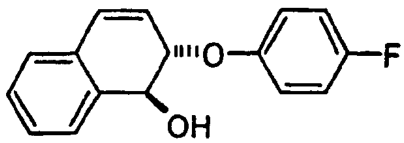
5

[0065] (1S,2S)-2-(4-acylphenoxy)-1,2,-dihydro-naphthalen-1-ol (5): To a flame dried round-bottomed flask, [Rh (COD)Cl]$_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^{t}Bu$_2$ (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-hydroxyacetophenone (472 mg, 3.47 mmol). The mixture was heated at 80° C for 2.5 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (30% ethyl acetate in hexanes) giving a white crystalline solid 5 (177 mg, 91%). The ee was determined to be > 99% by formation of Mosher's ester; R_f = 0.28 on silica (30% ethyl acetate in hexanes); mp 124-126°C (Et_2O); $[\alpha]^{25}_D$ = +153° (c = 9.8, $CHCl_3$). IR (KBr, cm^{-1}) 3367 (b), 3069 (w), 2916 (w), 1668 (s), 1601 (s), 1265 (s), 1053 (m), 835 (m), 779 (m); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94 (2H, d, *J*=8.8 Hz), 7.66-7.64 (1H, m), 7.34-7.27 (2H, m), 7.16-7.14 (1H, m), 6.98 (2H, d, *J*= 8.8 Hz), 6.57 (1H, d, *J*= 9.9 Hz), 5.99 (1H, d, *J*= 9.9 Hz), 5.21 (2H, s), 2.85 (1H, s), 2.56 (3H, s); ^{13}C NMR (400 MHz, $CDCl_3$): δ 196.8, 161.4, 135.3, 131.7, 130.7, 130.6, 129.6, 128.3, 128.1, 126.6, 125.4, 125.0, 115.2, 79.0, 72.0, 26.3. HRMS calcd for $(M-H_2O)^+$ ($C_{18}H_{14}O_2$): 262.0994. Found: 262.0989.



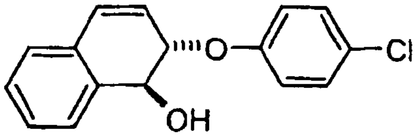
6

[0066] **(1S,2S)-2-(4-Trifluoromethylphenoxy)-1,2,-dihydro-naphthalen-1-ol (6):** To a flame dried round-bottomed flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^tBu_2 (3.8 mg, 0.0069 mmol) and **1** (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and4-trifluoromethylphenyl (563 mg, 3.47 mmol). The mixture was heated at 80° C for 8 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (10% ethyl acetate in hexanes) to give a white crystalline solid 6 (184 mg, 87%). The ee was determined to be 95% by HPLC analysis on a CHIRALCEL OD column, λ= 486 nm. Retention times in 4% isopropanol in hexanes were 14.8 min and 17.3 min (major). R_f= 0.46 on silica (20% ethyl acetate in hexanes); mp 118-119°C (Et_2O); $[\alpha]^{25}_D$ = +178° (c = 9.6, $CHCl_3$). IR (KBr, cm^{-1}) 3360 (br), 3061 (w), 2874 (w), 1617 (m), 1518 (m), 1326 (s), 1103 (s), 1051 (m), 839 (m), 782 (m), 745 (w); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63-7.54 (1H, m), 7.55 (2H, d, *J*= 8.6 Hz), 7.33-7.24 (2H, m), 7.14-7.12 (1H, m), 7.01 (2H, d, *J*= 8.6 Hz), 6.55 (1H, dd, *J*= 1.6, 9.9 Hz), 5.97 (1H, dd, *J*=2.0, 9.9 Hz), 5.21-5.13 (2H, m), 2.47 (1H, d, *J*= 3.6 Hz); ^{13}C NMR (400 MHz, $CDCl_3$): δ 159.9, 135.2, 131.7, 129.6, 128.4, 128.2, 127.1 (q, J^{C-F}= 3.6 Hz), 126.6, 125.4, 124.9, 123.4 (d, J^{C-F}= 33.0 Hz), 122.9 (d, J^{C-F}= 271.6 Hz), 115.6, 79.1, 72.1; HRMS calcd for (M^+) ($C_{17}H_{13}O_2F_3$): 306.0868. Found: 306.0852.



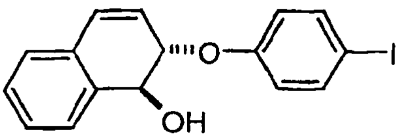
7

[0067] **(1S,2S)-2-(4-Fluorophenoxy)-1,2,-dihydro-naphthalen-1-ol (7):** To a flame dried round-bottomed flask, [Rh (COD)Cl]$_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^tBu_2 (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-fluorophenol (389 mg, 3.47 mmol). The mixture was heated at 80°C for 5 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (10% ethyl acetate in hexanes) giving a white crystalline solid **7** (163 mg, 92%). The ee was determined to be 97% by HPLC analysis on a CHIRALCEL OD column, λ= 486 nm). Retention times in 1.5% isopropanol in hexanes were 28.1 min (major) and 29.5 min. R_f = 0.39 on silica (20% ethyl acetate in hexanes); mp 127-129°C (Et_2O); $[\alpha]^{25}_D$ = +216° (c = 9.5, $CHCl_3$). IR (KBr, cm^{-1}) 3309 (b), 3071 (w), 2864 (w), 1504 (s), 1284 (m), 1052 (s), 781 (s), 692 (m); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63-7.61 (1H, m), 7.31-7.26 (2H, m), 7.12-7.10 (1H, m), 7.00-6.95 (2H, m), 6.92-6.88 (2H, m), 6.51 (1H, dd, *J*= 2.1, 9.9 Hz), 5.98 (1H, dd, *J*= 2.2, 9.9 Hz), 5.15 (1H, dd, *J*= 3.6, 10.0 Hz), 5.01 (1H, ddd, *J*= 2.1, 2.1, 10.1 Hz), 2.54 (1H, *d, J*=3.8 Hz); ^{13}C NMR (400 MHz, $CDCl_3$): δ 157.6 (d, J^{C-F}= 239 Hz), 156.4, 153.4, 135.4, 131.8, 129.1, 128.2, 126.5, 125.7, 125.2, 117.5 (d, J^{C-F}= 8 Hz), 116.1 (d, J^{C-F}= 23.5 Hz);. HRMS calcd for (M^+) ($C_{16}H_{13}O_2F$): 256.0810. Found: 256.0911.



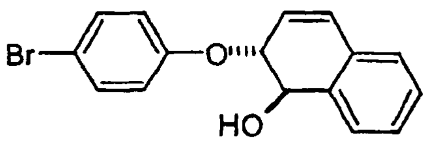
8

[0068] **(1S,2S)-2-(4-Chlorophenoxy)-1,2,-dihydro-naphthalen-1-ol (8):** To a flame dried round-bottomed flask, [Rh(COD)Cl]$_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^{t}Bu$_2$ (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-chlorophenol (446 mg, 3.47 mmol). The mixture was heated at 80°C for 6 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (5% ethyl acetate in hexanes) giving a white crystalline solid **8** (169 mg, 89%). The ee was determined to be 92% by formation of Mosher's ester. R_f = 0.47 on silica (20% ethyl acetate in hexanes); mp 1.25-125.5°C (Et_2O); $[\alpha]^{25}_D$ = +150° (c = 10.6, $CHCl_3$). IR (KBr, cm^{-1}) 3302 (br), 3064 (w), 2874 (w), 1590 (m), 1489 (s), 1362 (w), 1230 (s), 1052 (m), 890 (w), 846 (m), 778 (s), 663 (m); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.65-7.64 (1H, m), 7.33-7.26 (4H, m), 7.16-7.13 (1H, m), 6.91(1H, ddd, *J*= 2.0, 2.0, 8.9 Hz), 6.55 (1H, dd, *J*= 1.8, 9.9 Hz), 5.99 (1H, dd, *J*= 2.2, 9.9 Hz), 5.19 (1H, dd, *J*= 3.8, 10.0 Hz), 5.07 (1H, ddd, *J*= 2.0, 2.0, 10.1 Hz), 2.56 (1H, d, *J*= 4.0 Hz); ^{13}C NMR (400 MHz, $CDCl_3$): δ 155.8, 135.2, 131.7, 129.5, 129.3, 128.2, 128.1, 126.5, 126.2, 125.3, 125.2, 116.9, 79.2, 72.1. HRMS calcd for $(M-H_2O)^+$ ($C_{16}H_{11}OCl$): 254.0498. Found: 254.0499.



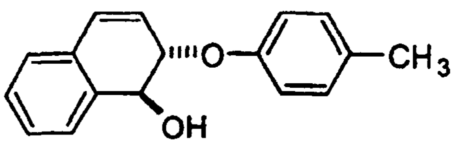
9

[0069] **(1S,2S)-2-(4-Iodophenoxy)-1,2,-dihydro-naphthalen-1-ol (9):** To a flame dried round-bottomed flask, [Rh(COD)Cl]$_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^{t}Bu$_2$ (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-iodophenol (763 mg, 3.47 mmol). The mixture was heated at 80°C for 12 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (10% ethyl acetate in hexanes) as a white crystalline solid **9** (193 mg, 73%). The ee was determined by deiodinating **9** (40 mg, 0.11 mmol) by reaction with t-BuLi (0.32 mL, 1.7M) in diethyl ether (2 mL) at -78°C followed by quenching with isopropanol. Extraction with ether from water, washing with brine, drying over anhydrous sodium sulfate and removal of the solvents in *vacuo* gave a white crystalline solid (24 mg, 92%). The ee was determined to be 98% by HPLC analysis on a CHIRALCEL OD column, λ= 256 nm. Retention times in 4% isopropanol in hexanes were 15.2 min (major) and 17.9 min; R_f = 0.44 on silica (20% ethyl acetate in hexanes); mp 160-162°C (Et_2O); $[\alpha]^{25}_D$ = +107° (c = 9.7, $CHCl_3$). IR (KBr, cm^{-1}) 3264 (br), 3050 (w), 2926 (w), 2843 (w), 1581 (m), 1485 (s), 1388 (w), 1279 (m), 1246 (s), 1046 (m), 824 (m), 780 (m), 571 (w); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63-7.61 (1H, m), 7.58-7.55 (2H, m), 7.30-7.27 (2H, m), 7.13-7.11 (1H, m), 6.73 (2H, ddd, *J*= 2.2, 2.2, 9.0 Hz), 6.52 (1H, dd, *J*= 1.8, 9.8 Hz), 5.96 (1H,dd, *J*= 2.2, 9.8 Hz), 5.16 (1H, d, *J*= 10.0 Hz), 5.05 (1H, ddd, *J*= 2.0, 2.0, 10.0 Hz), 2.54 (1H, s); ^{13}C NMR (400 MHz, $CDCl_3$): δ 157.3, 138.5, 135.3, 131.7, 129.4, 128.3, 128.1, 126.6, 125.3, 125.3, 118.1, 83.6, 79.2, 72.2. HRMS calcd for $(M-H_2O)^+$ ($C_{16}H_{11}OI$): 345.9855. Found: 345.9849.



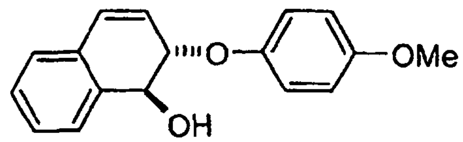
10

[0070] (1R,2R)-2-(4-Bromo-phenoxy)-1,2-dihydro-naphthalen-1-ol: To a flame dried round bottom flask, [Rh (COD)Cl]$_2$ (2.1 mg, 0.0043 mmol), (R)-(S)- PPF-P^{t}Bu$_2$ (4.6 mg, 0.0085 mmol, and 1 (122 mg, 0.85 mmol) were added.). THF (2 mL) and p-bromophenol (734 mg, 4.245 mmol) were then added followed by heating to 80°C for 1.5 hours. The reaction mixture was then poured in to ether and washed three times with 5% aqueous NaOH. The aqueous layers were combined and back extracted three times with ether. The organic layers were combined, washed with brine, dried over Na_2SO_4, and concentrated *in vacuo*. The resulting solid was purified by flash chromatography (20% ethyl acetate in hexanes) to give **10** a white crystalline solid (239.7 mg, 90%). The ee was determined by debrominating **10** (44 mg, 0.139 mmol) by reaction with t-BuLi (0.2 mL, 1.7M) in ether (2mL) at -78°C followed by quenching with isopropanol. Extraction with ether from water, washing with brine, drying over Na_2SO_4 and concentration gave a white crystalline solid 2 (31.5 mg, 95%). The ee was determined to be 96.8% by HPLC analysis on a CHIRALCEL OD column, λ= 486nm. Retention times in 4% isopropanol in hexanes were 15.2 min and 17.5 min (major). R_f= 0.26 on silica gel (10% ethyl acetate:hexanes); mp 145-146° (Et_2O); $[\alpha]^{25}_D$= -135.7° (c= 10.2, $CHCl_3$); IR (KBr, cm^{-1}) 3290 (br), 3060 (m), 2870 (w), 1583 (m), 1484 (s), 1227 (s), 1052 (m), 980 (s), 776 (s); ^{1}H NMR (400MHz, $CDCl_3$) δ 7.70-7.65 (1H, m), 7.44-7.42 (2H, m), 7.35-7.32 (2H, m), 7.18-7.16 (1H, m), 6.88-6.86 (2H, m), 6.56 (1H, dd, *J*= 10.0, 2.0 Hz), 6.00 (1H, dd, *J*= 9.7, 2.2 Hz), 5.20 (1H, dd, *J*= 9.7, 3.6 Hz), 5.09 (1H, ddd, *J*= 10.0, 2.0, 2.0 Hz), 2.70 (1H, d, *J*= 3.9 Hz); ^{13}C NMR (400MHz, $CDCl_3$) δ 156.5, 135.3, 132.5, 131.7, 129.3, 128.3, 128.1, 126.5, 125.3, 117.6, 113.7, 79.4, 72.2. HRMS calcd for $C_{16}H_{11}OBr$ $(M-H_2O)^+$ 297.9994. Found: 297.9995.



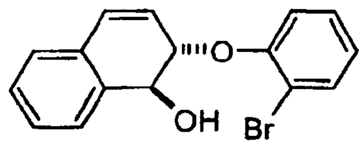
11

[0071] (1S,2S)-2-(4-Methylphenoxy)-1,2,-dihydro-naphthalen-1-ol (11): To a flame dried round-bottomed flask, [Rh(COD)Cl]$_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^{t}Bu$_2$ (3.8 mg, 0.0069 mmol) and **1** (50 mg, 0.347 mmol) were added followed by addition of THF (2.5 mL) and p-cresol (188 mg, 1.74 mmol). The mixture was heated at 80°C for 24 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (5% ethyl acetate in hexanes) giving a white crystalline solid **11** (57 mg, 65%). The ee was determined to be 91% by HPLC analysis on a CHIRALCEL OD column, λ=256 nm. Retention times in 1% isopropanol in hexanes were 33.8 min (major) and 37.1 min. R_f= 0.49 on silica (20% ethyl acetate in hexanes); mp 80-81°C (Et_2O); $[\alpha]^{25}_D$ = +145° (c = 12.1, $CHCl_3$). IR (KBr, cm^{-1}) 3303 (br), 3050 (w), 2210 (m), 1598 (s), 1503 (s), 1238 (s), 1025 (m), 859 (m), 778 (m); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67-7.65 (1H, m), 7.33-7.28 (2H, m), 7.14-7.11 (3H, m), 6.88 (2H, d, *J*= 8.4 Hz), 6.51 (1H, dd, *J*= 1.8, 9.9 Hz), 6.04 (1H, dd, *J*= 2.0, 9.9 Hz), 5.20 (1H, dd, *J*= 1.6, 10.2 Hz), 5.09 (1H, ddd, *J*= 1.8, 1.8, 10.2 Hz), 2.87 (1H, d, *J*= 2.7 Hz), 2.33 (3H, s). ^{13}C NMR (400 MHz, $CDCl_3$): δ 155.0, 135.4, 131.8, 130.7, 130.1, 128.8, 128.1, 127.9, 126.4, 126.2, 125.1, 115.6,79.0,72.3,20.5. HRMS calcd for (M^+) $(C_{17}H_{16}O_2)$: 252.1150. Found: 252.1140.



12

[0072] **(1S,2S)-2-(4-Methoxyphenoxy)-1,2,-dibydro-naphthalen-1-ol (12)**: To a flame dried round-bottomed flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^tBu_2 (3.8 mg, 0.0069 mmol) and 1 (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 4-methoxyphenol (431 mg, 3.47 mmol). The mixture was heated at 80°C for 6 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (10% ethyl acetate in hexanes) as a white crystalline solid **12** (159 mg, 85%). The ee was determined to be 95% by HPLC analysis on a CHIRALCEL OD column, λ= 256 nm. Retention times in 4% isopropanol in hexanes were 22.1 min (major) and 25.9 min. R_f= 0.33 on silica (20% ethyl acetate in hexanes); mp 91-92°C (Et_2O); $[\alpha]^{25}_D$ = +129° (c = 9.9, $CHCl_3$); IR (KBr, cm^{-1}) 3349 (br), 3050 (w), 2822 (w), 1508 (s), 1233 (s), 1046 (m), 825 (m), 751 (m), 695 (w); ^1H NMR (400 MHz, $CDCl_3$): δ 7.66-7.64 (1H, m), 7.30-7.27 (2H, m), 7.12-7.10 (1H, m), 6.91 (2H, ddd, *J*= 2.3, 2.3, 9.1 Hz), 6.84 (2H, ddd, *J*= 2.4, 2.4, 9.2 Hz), 6.49 (1H, dd, *J*= 2.0, 9.9 Hz), 6.02 (1H, dd, *J*= 2.4, 9.9 Hz), 5.17 (1H, dd, *J*= 3.3, 10.1 Hz), 5.02 (1H, ddd, *J*= 2.0, 2.0, 10.3 Hz), 3.77 (3H, s), 3.12 (1H, d, *J*= 3.4 Hz). ^{13}C NMR (400 MHz, $CDCl_3$): δ 154.3, 151.2,135.5, 131.9, 128.7, 128.1, 127.9, 126.4, 126.3, 125.2, 117.2, 114.8, 80.0, 72.4, 55.7. HRMS calcd for (M^+) ($C_{17}H_{14}O_2$): 250.0994. Found: 250.1006.



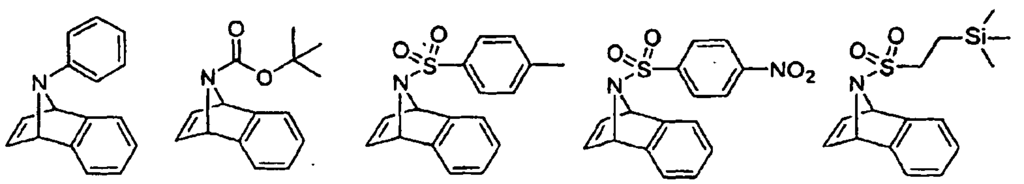
13

[0073] **(1S,2S)-2-(2-Bromophenoxy)-1,2,-dihydro-naphthalen-1-ol (13)**: To a flame dried round-bottomed flask, $[Rh(COD)Cl]_2$ (1.7 mg, 0.0035 mmol), (S)-(R)- PPF-P^tBu_2 (3.8 mg, 0.0069 mmol) and **1** (100 mg, 0.694 mmol) were added followed by addition of THF (2.5 mL) and 2-bromophenol (0.40 mL, 3.47 mmol). The mixture was heated at 80°C for 24 hours, then poured into diethyl ether and extracted 3 times with 10% aqueous sodium hydroxide solution. The aqueous extracts were combined and back-extracted three times with diethyl ether. The combined ether extracts were washed with brine and dried with anhydrous sodium sulfate. The solvents were removed *in vacuo*, yielding a solid which was purified by flash chromatography on silica gel (5% ethyl acetate in hexanes) as a white crystalline solid 13 (75 mg, 37%). The ee was determined to be 81% by HPLC analysis on a CHIRALCEL OD column, λ= 486 nm. Retention times in 1.5% isopropanol in hexanes were 22.8 min and 32.1 min (major). R_f = 0.44 on silica (20% ethyl acetate in hexanes); mp 120-122°C (Et_2O); $[\alpha]^{25}_D$ = +254° (c = 9.2, $CHCl_3$). IR (KBr, cm^{-1}) 3341 (br), 3071 (w), 2884 (w), 1581 (m), 1472 (s), 1358 (m), 1237 (s), 1028 (s), 987 (s), 780 (s), 689 (m), 569 (m); ^1H NMR (400 MHz, $CDCl_3$): δ 7.67 (1H, d *J*=6.8 Hz), 7.58 (1H, dd, *J*= 1.5, 7.9 Hz), 7.33-7.23 (3H, m), 7.14-7.12 (1H, m), 6.95(1H, dd, *J*= 1.1, 8.2 Hz), 6.92-6.87 (1H, m), 6.52 (1H, dd, *J*= 2.0, 9.9 Hz), 6.06 (1H, dd, *J*= 1.8, 9.9 Hz), 5.32 (1H, d, *J*= 11. 0 Hz), 5.10 (1H, ddd, *J*= 2.0, 2.0, 11.0 Hz), 2.85 (1H, d, *J*= 3.2 Hz). ^{13}C NMR (400 MHz, $CDCl_3$): δ 154.3, 135.4, 133.6, 131.8, 129.1, 128.6, 128.3, 128.0, 126.4, 126.0, 124.9, 122.9, 115.6, 113.5, 82.2, 72.5. HRMS calculated for $(M-H_2O)^+$ ($C_{16}H_{11}OBr$): 297.9993. Found: 297.9976.

II. Compounds Made Using Azabicyclics

Example 8: Azabicyclic Starting Materials:

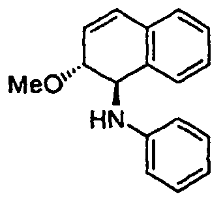
[0074]



1 2 3 4 5

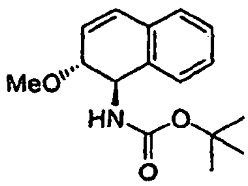
Example 9: Compounds Formed in Reactions Involving Alcohols

[0075]



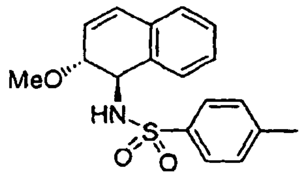
6

[0076] To a round bottomed flask was added 1 (44 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) and MeOH (1 ml) were then added and the solution heated to reflux for 6 hours. The reaction mixture was then concentrated and chromatographed to give 6 (28 mg, 56%) a colourless oil. ^{1}H NMR (400MHz, $CDCl_3$) δ 7.35 (1H, d, *J*= 7.2Hz), 7.28-7.13 (4H, m), 6.76-6.68 (4H, m), 6.64 (1H, d, *J*=9.9Hz), 6.11 (1H, dd, *J*= 4.0, 9.7Hz), 5.73 (1H, d, *J*= 6.0Hz), 4.21 (1H, dd, *J*= 4.3, 4.3Hz), 3.82 (1H, s), 3.42 (3 H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 147.1, 135.2, 132.0, 129.9, 129.4, 129.3, 128.4, 128.3, 128.1, 127.0, 126.5, 126.5, 75.8, 56.1, 55.8. HRMS calcd for $C_{17}H_{17}NO$ (M^+): 251.1310. Found: 251.1315.



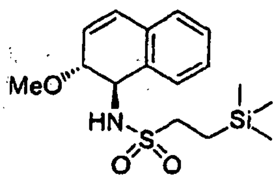
7

To a round bottomed flask was added **2** (49 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) and MeOH (1 ml) were then added and the solution heated to reflux for 48 hours. The reaction mixture was then concentrated and chromatographed (10% ethyl acetate:hexanes) to give **7** (41 mg, 74%) a white solid. The regiochemistry and relative stereochemistry was proven by X-ray crystal diffraction. R_f= 0.25 on silica gel (10% ethyl acetate:hexanes); ^{1}H NMR (400MHz, $CDCl_3$) δ 7.35-7.34 (1H, m), 7.25-7.20 (2H, m), 7.10-7.08 (1H, m), 6.58 (2H, d, *J*= 9.7Hz), 6.07 (1H, dd, *J*= 4.3, 9.7Hz), 4.98 (1H, dd, *J*= 5.5, 8.0Hz), 4.61 (1H, d, *J*= 7.7Hz), 4.00 (1H, dd, *J*= 4.6, 4.6Hz), 3.45 (3H, s), 1.44 (9H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 155.3, 134.1, 131.9, 130.0, 130.0, 128.3, 128.3, 127.0, 125.9, 79.6, 56.3, 51.3, 28.4. HRMS calcd for $C_{16}H_{21}NO_3$ (M^+): 275.1521. Found: 275.1518.



8

[0077] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) and MeOH (1 ml) were then added and the solution heated to reflux for 9 hours (Note: **3** and **8** nearly co-spot by TLC but 8 stains red with permanganate whereas 3 stains white). The reaction mixture was then concentrated and chromatographed to give **8** (60 mg, 91 %) a crystalline solid. mp 128-129°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.78 (2H, d, J= 8.0Hz), 7.33 (2H, d, J= 7.9Hz), 7.25-7.18 (1H, m), 7.11-7.04 (2H, m), 6.80 (2H, d, J= 7.5Hz), 6.60 (1H, d, J= 9.7Hz), 6.06 (1H, dd, J= 5.1, 9.2Hz), 4.50 (2H, s (br)), 3.98 (1H, s), 2.29 (3H, s), 2.47 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 144.9, 137.2, 132.4, 131.7, 130.3, 129.6, 128.8, 128.4, 127.3, 124.9, 77.2, 56.5, 54.1, 21.6. Anal. Calcd for $C_{18}H_{19}NO_3S$: C, 65.63; H, 5.81; N, 4.25. Found: C, 65.74; H, 5.89; N, 4.19.

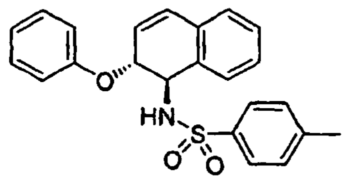


9

[0078] To a round bottomed flask was added **5** (61 mg, 0.2 mmol), $[Rh(COD)Cl]_2$(2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) and MeOH (1 ml) were then added and the solution heated to reflux for 6 hours. The reaction mixture was then concentrated and chromatographed to give 9 (53 mg, 78%) a colourless oil. ^{1}H NMR (400MHz, $CDCl_3$) δ 7.51-7.47 (1H, m), 7.30-7.24 (2H, m), 7.14-7.10 (1H, m), 6.59 (1H, d, J= 9.9Hz), 6.10 (1H, dd, J= 3.7, 9.9Hz), 5.41 (1H, dd, J= 8.8, 8.8Hz), 4.55 (1H, d, J= 8.8Hz), 4.06 (1H, dd, J= 3.6, 6.9Hz), 3.45 (3H, s), 3.04-2.95 (2H, m), 1.07-0.85 (2H, m), 0.03 (6H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 133.7, 131.9, 129.9, 128.7, 128.4, 127.7,127.2, 125.5, 77.3, 56.5, 55.5, 50.2, 10.5, -2.0. HRMS calcd for $C_{16}H_{25}NO_3SSi$ (M^+): 339.1324. Found: 339.1327.

Example 10: Compounds Formed in Reactions Involving Phenol Nucleophiles

[0079]

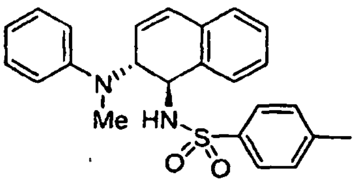


10

[0080] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) and PhOH (94 mg, 1.0 mmol) were added and the solution heated to reflux for 12 hours. The reaction mixture was then concentrated and chromatographed to give 10 (63 mg, 81 %) a crystalline solid. ^{1}H NMR (400MHz, $CDCl_3$) δ 7.72 (2H, d, J= 8.2Hz), 7.30-7.20 (5H, m), 7.14-7.09 (2H, m), 6.98-6.92 (1H, m), 6.87 (1H, d, J= 7.4Hz), 6.77 (2H, d, J= 8.4Hz), 6.64 (1H, d, J= 10.2Hz), 6.06 (1H, dd, J= 4.6, 9.2Hz), 5.00 (1H, dd, J= 4.7, 4.7Hz), 4.71-4.64 (2H, m), 2.44 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 156.8, 143.6, 137.5, 132.5, 131.7, 130.9, 129.7, 129.5, 128.9, 128.6, 128.2, 127.4, 127.4, 124.2, 121.4, 115.9, 73.2, 54.4, 21.5. Anal. Calcd for $C_{23}H_{21}NO_3S$: C, 70.56; H, 5.41; N, 3.58. Found: C, 70.58; H, 5.43; N, 4.18.

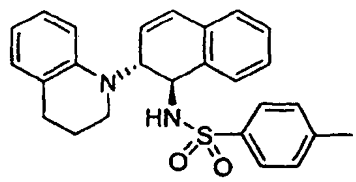
Example 11: Compounds Formed in Reactions Involving Nitrogen or Carbon Nucleophiles

[0081]



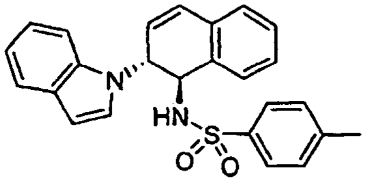
11

[0082] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) and N-methylaniline (107 mg, 1.0 mmol) were added and the solution heated to reflux for **8** hours. The reaction mixture was then concentrated and chromatographed to give **11** (72 mg, 89%) a crystalline solid. mp 136-142°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.62 (2H, d, *J*= 8.1Hz), 7.26-7.18 (4H, m), 7.14-7.08 (2H, m), 6.90 (1H, d, *J*= 7.3Hz), 6.80-6.68 (4H, m), 5.86 (1H, dd, *J*= 4.6, 9.9Hz), 4.73-4.53 (2H, m), 2.42 (3H, s), 2.34 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 148.9, 143.4, 137.5, 133.7, 132.2, 130.4, 129.6, 129.2, 128.7, 128.4, 127.7, 127.3, 127.0, 126.0, 117.6, 113.8, 58.9, 54.6, 32.3, 21.5. Anal. Calcd for $C_{24}H_{24}N_2O_2S$: C, 71.26; H, 5.98; N, 6.93. Found: C, 71.32; H, 6.01; N, 4.16.



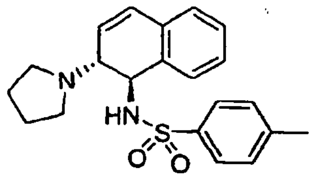
12

[0083] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) and tetrahydroquinoline (133 mg, 1.0 mmol) were added and the solution heated to reflux for 9 hours. The reaction mixture was then concentrated and chromatographed to give **12** (63 mg, 73%) a crystalline solid. mp 135-137°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.63 (2H, d, *J*= 8.2Hz), 7.25-7.20 (1H, m), 7.18 (2H, d, *J*= 8.2Hz), 7.11-7.00 (3H, m), 6.90 (1H, d, *J*= 6.4Hz), 6.83 (2H, d, *J*= 7.9Hz), 6.71 (1H, d, *J*= 9.7Hz), 6.64-6.58 (1H, m), 5.84 (1H, dd, *J*= 5.0, 9.7Hz), 4.83 (1H, d, *J*= 8.1Hz), 4.66 (1H, dd, *J*= 4.6, 4.6Hz), 4.58 (1H, dd, *J*= 4.7, 7.8Hz), 3.00-2.94 (1H, m), 2.62-2.40 (3H, m), 2.41 (3H, s), 1.60-1.52 (2H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 144.3, 143.2, 137.7, 133.8, 132.2, 130.7, 129.5, 129.5, 128.6, 128.2, 127.8, 127.1, 127.1, 127.0, 125.8, 123.3, 116.4, 111.7, 57.1, 53.9, 43.0, 28.0, 22.2, 21.5. Anal. Calcd for $C_{26}H_{26}N_2O_2S$: C, 72.53; H, 6.09; N, 6.51. Found: C, 72.55; H, 6.11; N, 6.50.



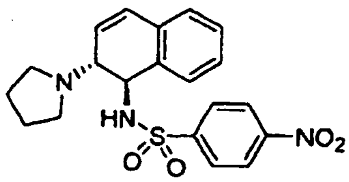
13

[0084] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) and indole (117 mg, 1.0 mmol) were added and the solution heated to reflux for 11 hours. The reaction mixture was then concentrated and chromatographed to give **13** (75 mg, 91%) a white solid. mp 132-135°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.84 (1H, s), 7.70-7.64 (3H, m), 7.24-7.07 (7H, m), 6.95-6.89 (1H, m), 6.65 (1H, d, *J*= 9.7Hz), 6.57 (1H, d, *J*=2.4Hz), 6.50 (1H, d, *J*= 7.5Hz), 6.09 (1H, dd, *J*= 5.1, 9.5Hz), 4.99 (1H, d, *J*= 7.7Hz), 4.54 (1H, dd, *J*= 2.9, 7.7Hz), 4.26-4.22 (1H, m), 2.38 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 143.2, 136.5, 132.4, 132.2, 132.2, 129.5, 128.9, 128.7, 128.6, 127.7, 127.1, 127.0, 126.4, 126.3, 122.5, 122.0, 119.5, 119.0, 112.2, 111.2, 56.0, 38.8, 21.5. HRMS calcd for $C_{25}H_{22}N_2O_2S$ (M^+): 414.1402. Found: 414.1407.



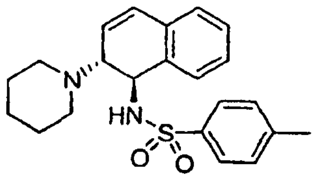
14

[0085] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) was then added followed by triethylamine hydrochloride (138 mg, 1.0 mmol) and pyrrolidine (83 μl, 1.0 mmol). The resulting heterogeneous mixture was heated to reflux for 14 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **14** (70 mg, 96%) a white solid. The regiochemistry and relative stereochemistry was proven by X-ray diffraction. ^1H NMR (400MHz, $CDCl_3$) δ 7.74 (2H, d, *J*= 8.3Hz), 7.30 (2H, d, *J*= 8.2Hz), 7.22-7.17 (1H, m), 7.08-7.02 (2H, m), 6.84 (1H, d, *J*= 7.5Hz), 6.61 (1H, d, *J*= 9.7Hz), 5.93 (1H, dd, *J*= 4.9, 9.7Hz), 4.70 (1H, br s), 4.45 (1H, d, *J*= 3.7Hz), 3.89 (1H, dd, *J*= 4.2, 4.2Hz), 2.58-2.49 (2H, m), 2.45 (3H, s), 2.36-2.29 (2H, m), 1.63-1.58 (4H, m); Anal. Calcd for $C_{21}H_{24}N_2O_2S$: C, 68.45; H, 6.56; N, 7.60. Found: C, 68.51; H, 6.62; N, 7.55.



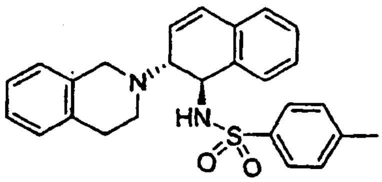
15

[0086] To a round bottomed flask was added **4** (66 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) was then added followed by triethylamine hydrochloride (138 mg, 1.0 mmol) and pyrrolidine (83 μl, 1.0 mmol). The resulting heterogeneous mixture was heated to reflux for 16 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **15** (67 mg, 84%) a white solid. mp 142-145°C; ^1H NMR (400MHz, $CDCl_3$) δ 8.30 (2H, d, *J*= 8.8Hz), 7.99 (2H, d, *J*= 8.8Hz), 7.24-7.18 (1H, m), 7.10-7.04 (2H, m), 6.95-6.90 (1H, m), 6.63 (1H, d, *J*= 9.9Hz), 5.93 (1H, dd, *J*= 4.7, 9.7Hz), 5.20-4.80 (1H, br s), 4.60 (1H, d, *J*= 3.8Hz), 3.40-3.35 (1H, m), 2.58-2.50 (2H, m), 2.43-2.34 (2H, m), 1.64-1.57 (4H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 149.8, 147.1, 132.8, 131.9, 129.7, 128.8, 128.2, 128.1, 128.0, 127.1, 125.0, 124.1, 61.4, 54.4, 50.0, 23.4. Anal. Calcd for $C_{20}H_{21}N_3O_4S$: C, 60.13; H, 5.30; N, 10.52. Found: C, 60.16; H, 5.33; N, 10.50.



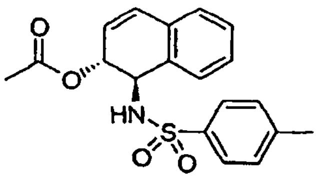
16

[0087] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) was then added followed by triethylamine (140 µl, 1.0 mmol) and piperidine hydrochloride (121 mg, 1.0 mmol). The resulting heterogeneous mixture was heated to reflux for 14 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **16** (72 mg, 94%) a white solid. mp 116-117°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.75 (2H, d, J= 8.2Hz), 7.30 (2H, d, J= 7.8Hz), 7.21-7.18 (1H, m), 7.10-7.05 (1H, m), 7.04 (1H, d, J= 7.5Hz), 6.94 (1H, d, J= 7.5Hz), 6.61 (1H, dd, J= 1.0, 9.7Hz), 5.91 (1H, dd, J= 4.8, 9.7Hz), 4.82 (1H, s (br)), 4.53 (1H, d, J= 4.4Hz), 3.38-3.35 (1H, m), 2.44 (3H, s), 2.41-2.34 (2H, m), 2.16-2.09 (2H, m), 1.40-1.26 (6H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 143.3, 137.7, 134.2, 132.2, 129.6, 129.4, 128.2, 128.0, 127.7, 127.2, 126.6, 125.0, 64.2, 50.9, 49.6, 26.2, 24.3, 21.5. HRMS calcd for $C_{22}H_{26}N_2O_2S$ (M^+): 382.1715. Found: 382.1713.



17

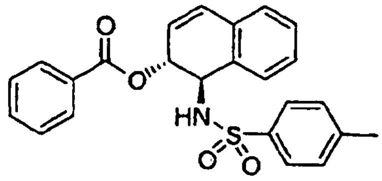
[0088] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (2 ml) was then added followed by triethylamine hydrochloride (138 mg, 1.0 mmol) and tetrahydroisoqinoline (125 µl, 1.0 mmol). The resulting heterogeneous mixture was heated to reflux for 15 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **17** (70 mg, 81%) a white solid. mp 142-146°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.73 (2H, d, J= 8.2Hz), 7.26-7.18 (3H, m), 7.12-6.98 (5H, m), 6.90 (1H, d, J= 8.1Hz), 6.80 (1H, d, J= 6.8Hz), 6.67 (1H, d, J= 9.7Hz), 5.95 (1H, dd, J= 4.7, 9.7Hz), 4.80 (1H, s), 4.62 (1H, s), 3.68 (1H, AB, d, J= 15.0Hz), 3.63 (1H, dd, J= 4.5, 4.5Hz), 3.40 (1H, AB, d, J= 15.0Hz), 2.68-2.56 (4H, m), 2.40 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 143.4, 137.7, 137.7, 134.1, 133.8, 132.2, 129.9, 129.6, 128.6, 128.5, 128.3, 127.9, 127.2, 126.8, 126.5, 125.9, 125.4, 124.6. Anal. Calcd for $C_{26}H_{26}N_2O_2S$: C, 72.53; H, 6.09; N, 6.51. Found: C, 72.56; H, 6.12; N, 6.50.



18

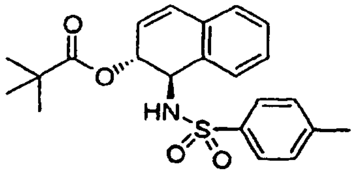
[0089] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) was then added followed by triethylamine hydrochloride (138 mg, 1.0 mmol) and potassium acetate (98 mg, 1.0 mmol). The resulting heterogeneous mixture was heated to reflux for 15 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **18** (63 mg, 88%) a white solid. ^1H

NMR (400MHz, $CDCl_3$) δ 7.77 (2H, d, J= 8.3Hz), 7.31(2H, d, J= 8.2Hz), 7.27-7.22 (1H, m), 7.19-7.07 (3H, m), 6.54 (1H, d, J= 10.2Hz), 5.88 (1H, dd, J= 3.7, 10.2Hz), 5.48 -5.44 (1H, m), 4.90 (1H, d, J= 8.4Hz), 4.74-4.69 (1H, m), 2.44 (3H, s), 1.78 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 170.6, 143.4, 138.2, 132.8, 131.9, 130.3, 129.7, 128.7, 128.5, 127.4, 127.1, 127.1, 125.0, 71.0, 55.7, 21.5, 20.7. Anal. Calcd for $C_{19}H_{19}NO_4S$: C, 63.85; H, 5.36; N, 3.92. Found: C, 63.88; H, 5.40; N, 3.81.



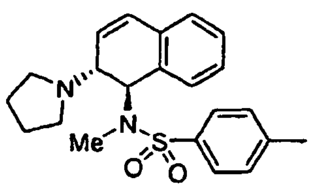
19

[0090] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) was then added followed by triethylamine (140 μl, 1.0 mmol) and benzoic acid (122 mg, 1.0 mmol). The resulting homogeneous solution was heated to reflux for 15 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **19** (73 mg, 87%) a white solid. mp 158-162°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.77 (2H, d, J= 7.1Hz), 7.65 (2H, d, J= 8.3Hz), 7.56-7.50 (1H, m), 7.40-7.32 (3H, m), 7.30-7.22 (2H, m), 7.11 (1H, dd, J= 1.3, 7.2Hz), 6.98 (2H, d, J=8.1Hz), 6.56 (1H, dd, J= 1.3, 9.9Hz), 5.93 (1H, dd, J= 3.3, 9.7Hz), 5.79 (1H, ddd, J= 1.7, 3.3, 9.2Hz), 5.12 (1H, d, J=8.4Hz), 4.90 (1H, dd, J=8.8, 8.8Hz), 2.19 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 166.4, 143.3, 138.0, 133.4, 133.3, 132.3, 130.4, 130.0, 129.7, 128.8, 128.8, 128.3, 127.5, 127.2, 126.9, 125.7, 72.3, 56.8,21.6. HRMS calcd for $C_{24}H_{21}NO_4S$ (M^+): 419.1191. Found: 419.1997.



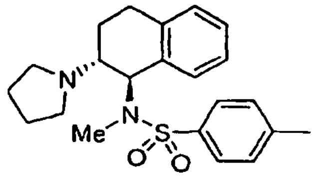
20

[0091] To a round bottomed flask was added **3** (60 mg, 0.2 mmol), $[Rh(COD)Cl]_2$ (2.5 mg, 0.005 mmol), and DPPF (5.5 mg, 0.01 mmol). THF (1 ml) was then added followed by triethylamine (140 μl, 1.0 mmol) and pivalic acid (102 mg, 1.0 mmol). The resulting homogeneous solution was heated to reflux for 15 hours. Upon completion, the reaction mixture was concentrated and chromatographed to give **20** (61 mg, 77%) a white solid. ^1H NMR (400MHz, $CDCl_3$) δ 7.75 (2H, d, J= 8.0Hz), 7.28 (2H, d, J= 8.0Hz), 7.16-7.00 (3H, m), 6.85 (1H, d, J= 7.6Hz), 6.55 (1H, d, J= 9.7Hz), 5.91 (1H, dd, J= 4.1, 9.7Hz), 5.34 (1H, dd, J= 5.9, 5.9Hz), 4.98 (1H, d, J= 8.4Hz), 4.70 (1H, dd, J= 7.3, 7.3Hz), 2.42 (3H, s), 1.07 (9H, s). HRMS calcd for $C_{22}H_{25}NO_4S$ (M^+): 399.1504. Found: 399.1507.



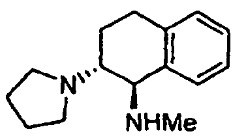
21

[0092] To a round bottomed flask was added **21** (100 mg, 0.27 mmol) and potassium carbonate (112 mg, 0.81 mmol). Acetone (3 ml) was then added followed by iodomethane (18 μl, 0.28 mmol). The mixture was stirred at room temperature for **4** hours then quenched with water. Extraction with ethylacetate, combining of the organic fractions and concentration gave a light yellow solid. Chromatography gave pure **21** (101 mg, 98%) a white crystalline solid. mp 109-111°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.86 (2H, d, J= 8.0Hz), 7.31 (2H, d, J= 8.0Hz), 7.26-7.12 (3H, m), 7.06 (1H, d, J= 6.9Hz), 6.58 (1H, d, J= 9.7Hz), 5.95 (1H, dd, J= 4.6, 9.9Hz), 5.35 (1H, d, J= 4.5Hz), 3.42 (1H, dd, J= 4.5, 4.5Hz), 2.62-2.48 (4H, m), 2.50 (3H, s), 2.45 (3H, s), 1.70-1.63 (4H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 143.0, 137.7, 133.6, 132.1, 129.5, 129.1, 128.9, 128.2, 128.1, 127.4, 126.5, 125.9, 58.2, 56.5, 48.6, 29.6, 23.5, 21.5. Anal. Calcd for $C_{22}H_{26}N_2O_2S$: C, 69.08; H, 6.85; N, 7.32. Found: C, 69.14; H, 6.91; N, 7.30.



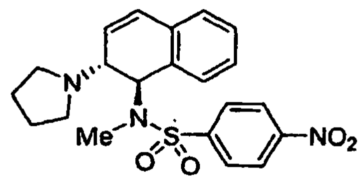
22

[0093] To a round bottomed flask was added **21** (100 mg, 0.26 mmol), ethylacetate (2 ml) and palladium on carbon (5mg). Hydrogen was added over this heterogeneous mixture via balloon for 15 hours. Upon completion, the mixture was filtred through celite and concentrated to give **22** a white solid. Crude ^{1}H NMR showed that this crude product was >95% pure. Further purification could be obtained by chromatography giving pure **22** (98 mg, 98%). mp 109-110°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 7.99 (2H, d, J= 8.1Hz), 7.30 (2H, d, J= 8.3Hz), 7.15-7.02 (4H, m), 5.29 (1H, d, J= 8.1Hz), 3.03-2.67 (5H, m), 2.65-2.52 (2H, m), 2.44 (3H, s), 2.43 (3H, s), 2.05-1.96 (1H, m), 1.90-1.80 (1H, m), 1.72-1.64 (4H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 142.8, 138.5, 137.5, 133.9, 129.2, 128.5, 127.7, 127.1, 126.4, 60.0, 59.3, 48.7, 30.3, 27.9, 23.6, 21.5, 21.4. Anal. Calcd for $C_{22}H_{28}N_2O_2S$: C, 68.72; H, 7.34; N, 7.29. Found: C, 68.79; H, 7.37; N, 7.22.



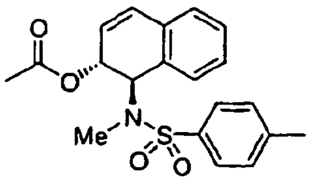
23

[0094] To a quartz tube was added **22** (80 mg, 0.2 mmol), 1,4-dimethoxybenzene (110 mg, 0.8 mmol) and sodium borohydride (76 mg, 2.0 mmol) followed by 90% aqueous ethanol solution (3 ml). The mixture was irradiated at 254 nm in a rayonet reactor for 2.5 hours. The crude mixture was concentrated azeotropically with ethanol and then chromatographed (90% acetone, 9% MeOH, 1% triethylamine) to give **23** (42 mg, 91%). Spectral data was identical to the literature data.



24

[0095] To a round bottomed flask was added **16** (100 mg, 0.25 mmol) and potassium carbonate (112 mg, 0.81 mmol). Acetone (3 ml) was then added followed by iodomethane (18 μl, 0.28 mmol). The mixture was stirred at room temperature for 4 hours then quenched with water. Extraction with ethylacetate, combining of the organic fractions and concentration gave a light yellow solid. Chromatography gave pure **24** (101 mg, 98%) a white crystalline solid. mp 139-141°C; ^{1}H NMR (400MHz, $CDCl_3$) δ 8.35 (2H, d, J= 8.8Hz), 8.22 (2H, d, J= 8.8Hz), 7.28-7.22 (3H, m), 7.09 (1H, d, J= 6.2Hz), 6.60 (1H, d, J= 9.9Hz), 5.95 (1H, dd, J= 4.0, 9.9Hz), 5.43 (1H, d, J= 6.6Hz), 3.54-3.49 (1H, m), 2.62 (3H, s), 2.60-2.54 (4H, m), 1.72-1.66 (4H, m); ^{13}C NMR (400MHz, $CDCl_3$) δ 149.8, 146.6, 133.6, 131.6, 129.5, 128.6, 128.3, 128.0, 126.8, 125.3, 124.0, 58.4, 58.0, 48.5, 29.8, 23.7. Anal. Calcd for $C_{21}H_{23}N_3O_4S$: C, 61.00; H, 5.61; N, 10.16. Found: C, 61.11; H, 5.65; N, 10.12.



25

[0096] To a round bottomed flask was added **18** (70 mg, 0.20 mmol) and potassium carbonate (110 mg, 0.80 mmol). Acetone (2.5 ml) was then added followed by iodomethane (15 µl, 0.24 mmol). The mixture was stirred at room temperature for 4 hours then quenched with water. Extraction with ethylacetate, combining of the organic fractions and concentration gave a light yellow solid. Chromatography gave pure **25** (67 mg, 91 %) a white crystalline solid. mp 113-116°C; ^1H NMR (400MHz, $CDCl_3$) δ 7.78 (2H, d, *J*= 8.2Hz), 7.32 (2H, d, *J*= 8.2Hz), 7.25-7.17 (2H, m), 7.13-6.98 (2H, m), 6.46 (1H, dd, *J*= 1.8, 9.9Hz), 5.85 (1H, dd, *J*= 2.9, 9.9Hz), 5.71 (1H, ddd, *J*= 2.0, 2.6, 10.1Hz), 5.60 (1H, d, *J*= 10.1Hz), 2.69 (3H, s), 2.44 (3H, s), 1.90 (3H, s); ^{13}C NMR (400MHz, $CDCl_3$) δ 170.2, 143.4, 137.3, 133.2, 131.4, 129.6, 129.2, 128.4, 128.3, 127.1, 126.7, 126.4, 69.7, 60.0, 29.5, 21.4, 20.8. Anal. Calcd for $C_{20}H_{21}NO_4S$: C, 64.67; H, 5.70; N, 3.77. Found: C, 64.75; H, 5.77; N, 3.72.

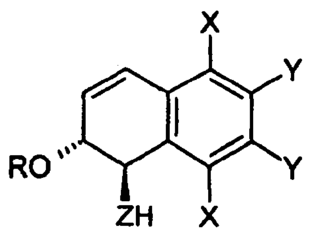
Abbreviations

[0097]

ee	"enantiomerically enriched," or "enantiomeric enrichment"
THF	tetrahydrofuran
DPPE	1,2-bis(diphenylphosphino)ethane
BINAP	2,2'-bis(diphenylphosphino)-1,1'-binaphthyl

Claims

1. A compound according to formula I:



(I)

wherein R is $-(CH_2)_nR_1$ and R_1 is a C_3-C_6 aryl optionally substituted at one or more positions with a group selected from: Cl; F; NO_2; I; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy and wherein n=0-3;
wherein X and Y are independently selected from the group consisting of H; NH_2; F; Cl; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy;
or wherein adjacent X and Y or Y and Y together with the carbon atoms to which they are attached from form a

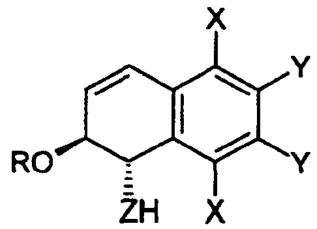
C_3-C_6 carbocyclic ring or a C_3-C_6 heterocyclic ring containing one or more heteroatoms selected from the group consisting of: O; N; and S; and
wherein Z is selected from O or NR_a, wherein R_a is selected from:

(i) phenyl;
(j) (O)C-O-R_b , wherein R_b is a straight or branched C_1-C_6 alkyl;
(k) -SO_2-R_c, wherein R_c is selected from the group consisting of:

i) C_1-C_6 straight or branched alkyl;
ii) -$(CH_2)_qR_e$, wherein q=O-3 and R_e is a C_3-C_6 aryl, optionally substituted at one or more positions with a group selected from: Cl; F; NO_2; CN; I; Br; a straight or branched C_1-C_3 alkyl; a C_1-C_3 alkoxy; and -C(O)R_f, wherein R_f is a C_1-C_3 alkyl; -$(CH_2)_rCF_3$, wherein r=0-3;
iii) -$R_g(CF_3)_s$, wherein R_g is a C_1-C_3 straight or branched alkyl and s=1-3;
iv) -$(CH_2)_s$-TMS, wherein TMS = trimethylsilyl and s= 1-3;

(l) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ wherein q is 1-3.

2. A compound according to formula II:



(II)

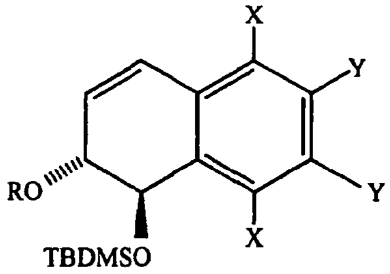
wherein R is -$(CH_2)_qR_5$ wherein q=0-3 and R_5 is a C_3-C_6 aryl optionally substituted at one or more positions with a group selected from: a straight or branched C_1-C_3 alkyl; a C_1-C_3 alkoxy; I; Cl; CN; F; NO_2; -$(CH_2)_rCF_3$, wherein r=0-3; and -C(O)R_6, wherein R_6 is a C_1-C_3 alkyl;
wherein X and Y are independently selected from the group consisting of H; NH_2; F; Cl; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy;
or wherein adjacent X and Y or Y and Y together with the carbon atoms to which they are attached from form a C_3-C_6 carbocyclic ring or a C_3-C_6 heterocyclic ring containing one or more heteroatoms selected from the group consisting of: O; N; and S; and
wherein Z is selected from O or NR_a, wherein R_a is selected from:

(e) phenyl;
(f) (O)C-O-R_b, wherein R_b is a straight or branched C_1-C_6 alkyl;
(g) -SO_2-R_c, wherein R_c is selected from the group consisting of:

i) C_1-C_6 straight or branched alkyl; ii) -$(CH_2)_qR_e$, wherein q=0-3 and R_e is a C_3-C_6 aryl, optionally substituted at one or more positions with a group selected from: Cl; F; NO_2; CN; I; Br; a straight or branched C_1-C_3 alkyl; a C_1-C_3 alkoxy; and -C(O)R_f, wherein R_f is a C_1-C_3 alkyl; -$(CH_2)_rCF_3$, wherein r=0-3;
iii) -$R_g(CF_3)_s$, wherein R_g is a C_1-C_3 straight or branched alkyl and s=1-3;
iv) -$(CH_2)_s$-TMS, wherein TMS = trimethylsilyl and s= 1-3;

(h) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ wherein q is 1-3.

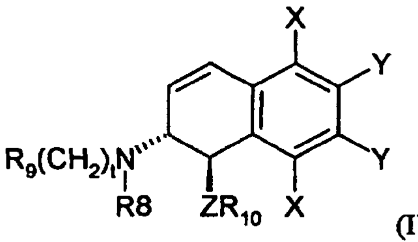
3. A compound according to formula III:



(III)

wherein TBDMSO is a tert-butyldimethylsiloxy group, and R, X, and Y are as defined in claim 1.

4. A compound according to formula IV:



(IV)

wherein:

a) R_8 is H, CH_3 or as defined in c);
b) t=0-3;
c) R_9 is a C_3-C_6 aryl optionally substituted at one or more positions with a group selected from: a C_1-C_3 alkyl; a C_1-C_3 alkoxy; Cl; F; NO_2; and CF_3; or R_9 together with N, R_8 and $(CH_2)_t$ of formula IV forms a ring structure selected from: a phthalamide ring; a pyrrolidine ring; a piperidine ring; a tetrahydroquinoline ring; and an indole ring; said ring structure being optionally substituted at one or more positions with a group selected from: a C_1-C_3 alkyl; a C_1-C_3 alkoxy; Cl; F; NO_2; and CF_3;
d) X and Y are independently selected from the group consisting of H; NH_2; F; Cl; Br; a C_1-C_3 alkyl; and a C_1-C_3 alkoxy; or wherein adjacent X and Y or Y and Y together with the carbon atoms to which they are attached from form a C_3-C_6 carbocyclic ring or a C_3-C_6 heterocyclic ring containing one or more heteroatoms selected from the group consisting of: O; N; and S;
e) Z is selected from O or NR_a, wherein R_a is selected from:

(i) a straight or branched C_1-C_6 alkyl;
(ii) phenyl;
(iii) (O)C-O-R_b, wherein R_b is a straight or branched C_1-C_6 alkyl;
(iv) -SO_2-R_c, wherein R_c is an unsubstituted phenyl or a phenyl substituted with a C_1-C_3 alkyl or NO_2; and
(v) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ wherein q isl-3; and

f) when Z is O, R_{10} is H; when Z is NR_a, R_{10} is either H or CH_3.

5. The compound of any one of claims 1-4, wherein X=H and Y=H.

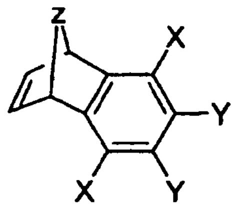
6. A compound selected from the group consisting of:

(1S,2S)-2-methoxy-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(ethoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(isopropoxy)-1,2-dihydro-naphthalen-1-ol;

(1S,2S)-2-(1-propenyloxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(2-trimethylsilyl-ethoxy)1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-benzyloxy-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-methoxybenzyloxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(2,2,2-trifluoro-ethoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(2,2,2-trifluoro-1-trifluoromethyl-ethoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-6,7-difluoro-2-methoxy-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-6-methoxy-5,6-dihydro-naphthol[2,3-d][1,3]dioxol-5-ol;
(1S,2S)-6,7-dibromo-2-methoxy-5,8-dimethyl-1,2-dihydro-naphthalen-1-ol;
(1R*,2R*)-acetic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
(1R*,2R*)-propionic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
(1R,2R)-benzoic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
(1R*,2R*)-formic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
(1R*,2R*)-2-methyl acrylic acid 1-hydroxy-1,2-dihydro-naphthalen-2-yl-ester;
(1R*,2R*)-malonic acid ethyl ester (1-hydroxy-1,2-dihydro-naphthalen-2-yl) ester;
(1R*,2R*)-malonic acid (1-tert-butylbimethylsiloxy-1,2-dihydro-naphthalen-2-yl) ethyl ester;
(1S*,2S*)(4-tert-butyldimethylsiloxy-1,4-dihydro-naphthalen-2-yl) acetic acid ethyl ester;
(1R,2R)-2-(1-hydroxy-1,2-dihydro-naphthalen-2-yl)-isoindole-1,3-dione;
(1S,2S)-N-(1-hydroxy-1,2-dihydro-naphthalen-2-yl)-benzene sulfonamide;
(1R*,2R*)-2-pyrrolidin-1-yl-1,2-dihydro-naphthalen-1-ol;
(1R*,2R*)-2-piperidin-1-yl-1,2-dihydro-naphthalen-1-ol;
(1R,2R)-2-(3,4-dihydro-2H-quinolin-1-yl)-1,2-dihydro-naphthalen-1-ol;
(1R,2R)-2-(methyl-phenyl-amino)-1,2-dihydro-naphthalen-1-ol;
(1R*,2R*)-2-benzylamino-1,2-dihydro-naphthalen-1-ol;
(1R*,2R*)-2-(4-methoxy-benzylamino)-1,2-dihydro-naphthalen-1-ol;
(1R,2R)-2-indol-1-yl-1,2-dihydro-naphthalen-1-ol;
(1S*,2R*)-2-(hydroxy-1,2-dihydro-naphthalen-2-yl)malonic acid dimethyl ester;
(1S,2S)-2-phenoxy-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-nitrophenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-cyanophenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-acylphenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-trifluoromethylphenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-fluorophenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-chlorophenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-iodophenoxy)-1,2-dihydro-naphthalen-1-ol;
(1R,2R)-2-(4-bromo-phenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-methylphenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(4-methoxyphenoxy)-1,2-dihydro-naphthalen-1-ol;
(1S,2S)-2-(2-bromophenoxy)-1,2-dihydro-naphthalen-1-ol;
4-methyl-N-[(1R, 2S)-2-(1-piperidinyl)-1,2-dihydro-1-naphthalenyl]benzenesulfonamide;
N-[(1R,2S)-2-(3,4-dihydro-1(2H)-quinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
N-[(1R,2S)-2-(3,4-dihydro-2(1H-isoquinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
N-[(1R,2S)-2-(1H-indol-1-yl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzenesulfonmidde;
(1R,2S)-2-methoxy-N-phenyl- 1,2-dihydro-1 -naphthalenamine;
tert-butyl (1R,2S)-2-methoxy- 1,2-dihydro- 1 -naphthalenylcarbamate;
N-[(1R,2S)-2-methoxy-1,2-dihydro-1-naphthalenyl]-2-(trimethylsilyl)ethanesulfonamide;
N,4-dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenyl]-benzenesulfonamide;
N,4-dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]-benzenesulfonamide;
N-hydroxy-4-({methyl[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyllamino}sulfonyl) -N-oxobenzenaminium;
N-methyl-4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]-benzenesulfonamide;
(1R,2S)-N-methyl-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenamine;
N-[(1R, 2S)-2-methoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
N-[(1R,2S)-2-methoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzenesulfonamide;
4-methyl-N-[(1R,2S)-2-phenoxy-1,2,3,4-tetrahydro-1-naphthalenyl]benzenesulfonamide;
(1R,2S)-1-{[(4-methylphenyl)sulfonyl]amino)-1,2,3,4-tetrahydro-2-naphthalenyl acetate;
(1R,2S)-1-{[(4-methylphenyl)sulfonyl]amino}-1,2-dihydro-2-naphthalenyl benzoate;
(1R,2S)-1-{[(4-methylphenyl)sulfonyl]amino1,2-dihydro-2-naphthalenyl pivalate;

N-[(1R,2S)-2-methoxy-1,2-dihydro-1-naphthalenyl]-2-(trimethylsilyl)ethanesulfonamide;
tert-butyl (1R,2S)-2-methoxy-1,2-dihydro-1-naphthalenylcarbamate; and
4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]benzenesulfonamide.

7. A process for preparing a compound according to formula I of claim 1, comprising reacting a compound of formula ROH with a compound of formula V:

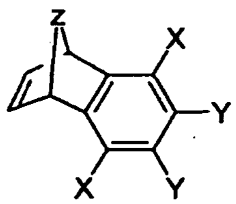


(V)

wherein R, X, Y and Z are as defined in claim 1;
and wherein said reaction is catalyzed by $[Rh(COD)Cl]_2$ in the presence of a first chiral phosphine ligand.

8. The process of claim 7, wherein said first chiral phosphine ligand is selected from the group consisting of: DPPF; (R)-(S)-BPPFA; and (R)-(S)-PPF-P^tBu_2.

9. A process for preparing a compound according to formula II of claim 2, comprising reacting a compound of formula ROH with a compound of formula V:



(V)

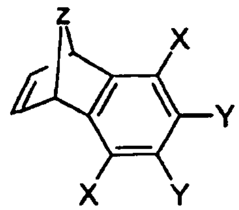
wherein R, X, Y and Z are as defined in claim 3;
and wherein said reaction is catalyzed by $[Rh(COD)Cl]_2$ in the presence of a second chiral phosphine ligand.

10. The process of claim 9, wherein said second chiral phosphine ligand is (S)-(R)-PPF-P^tBu_2.

11. A process for preparing a compound according to formula III of claim 3, comprising:

(a) preparing a compound of formula I according to the process of claim 7; and
(b) reacting the compound formed in step (a) with a salt of tert-butyldimethylsilylic acid.

12. A process for preparing a compound of formula IV according to claim 4, comprising reacting a compound of formula R_9-$(CH_2)_t NHR_8$ with a compound of formula V



(V)

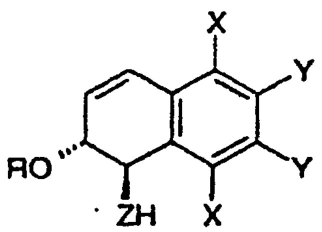
wherein R_8, R_9, t, X, Y and Z are as defined in claim 4 and wherein said reaction is catalyzed by $[Rh(COD)Cl]_2$ in the presence of a chiral phosphine ligand.

13. The process of claim 12, wherein said chiral phosphine ligand is selected from the group consisting of: DPPF; (R)-(S)-BPPFA; and (R)-(S)-PPF-P^tBu_2.

14. The process of claim 13, wherein R_9 together with N form a ring selected from the group consisting of: a phthalamide ring; a pyrrolidine ring; a piperidine ring; a tetrahydroquinoline ring; and an indole ring; said ring structure being optionally substituted at one or more positions with a group selected from: a C_1-C_3 alkyl; a C_1-C_3 alkoxy; Cl; F; NO_2; and CF_3.

Patentansprüche

1. Verbindung der Formel I:



(I)

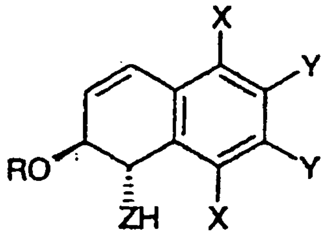
in der
R -$(CH_2)_nR_1$ bedeutet und R_1 ein C_3-C_6-Aryl, gegebenenfalls in einer oder mehreren Stellungen substituiert durch eine Gruppe aus der Reihe Cl, F, NO_2, I, Br, ein C_1-C_3-Alkyl und ein C_1-C_3-Alkoxy, wobei n=0-3, bedeutet;
in der X und Y unabhängig aus der Gruppe H, NH_2, F, Cl, Br, C_1-C_3-Alkyl und C_1-C_3-Alkoxy stammen;
oder in der benachbarte X und Y oder Y und
Y gemeinsam mit den Kohlenstoffatomen, an die sie gebunden sind, einen C_3-C_6-Carbocyclus oder einen C_3-C_6-Heterocyclus, der ein oder mehrere Heteroatome aus der Gruppe O, N und S enthält, bilden, und
in der Z aus der Reihe O oder NR_a stammt, wobei R_a aus der folgenden Gruppe stammt:

(i) Phenyl;
(j) (O)C-O-R_b, wobei R_b ein geradkettiges oder verzweigtes C_1-C_6-Alkyl bedeutet;
(k) -SO_2-R_c, wobei R_c aus der folgenden Gruppe stammt:

i) geradkettiges oder verzweigtes C_1-C_6-Alkyl;
ii) -$(CH_2)_qR_c$, wobei q=0-3 und R_e ein C_3-C_6-Aryl, gegebenenfalls in einer oder mehreren Stellungen substituiert durch eine Gruppe aus der Reihe: Cl; F; NO_2; CN; I; Br; ein geradkettiges oder verzweigtes C_1-C_3-Alkyl; ein C_1-C_3-Alkoxy und -C(O)R_f, wobei R_f ein C_1-C_3-Alkyl bedeutet; -$(CH_2)_rCF_3$, wobei r=0-3; bedeutet;
iii) -$R_g(CF_3)_s$, wobei R_g ein geradkettiges oder verzweigtes C_1-C_3-Alkyl bedeutet und s=1-3;
iv) -$(CH_2)_s$-TMS, wobei TMS = Trimethylsilyl und s=1-3;

(1) $-SO_2-(CH_2)_q-Si(CH_3)_3$, wobei q 1-3 bedeutet.

2. Verbindung der Formel II,



(II)

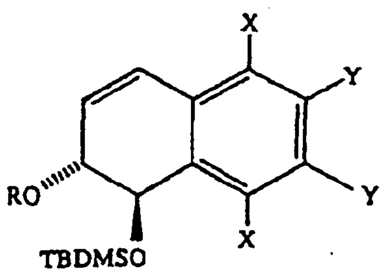
in der R $-(CH_2)_qR_5$ bedeutet, wobei q=0-3 und R_5 ein C_3-C_6-Aryl, gegebenenfalls in einer oder mehreren Stellungen substituiert durch eine Gruppe aus der Reihe: geradkettiges oder verzweigtes C_1-C_3-Alkyl, C_1-C_3-Alkoxy, I, Cl, CN, F, NO_2, $-(CH_2)_rCF_3$, wobei r=0-3, und $-C(O)R_6$, wobei R_6 ein C_1-C_3-Alkyl bedeutet, bedeutet;
in der X und Y unabhängig aus der Gruppe H, NH_2, F, Cl, Br, C_1-C_3-Alkyl und C_1-C_3-Alkoxy stammen; oder in der benachbarte X und Y oder Y und Y gemeinsam mit den Kohlenstoffatomen, an die sie gebunden sind, einen C_3-C_6-Carbocyclus oder einen C_3-C_6-Heterocyclus, der ein oder mehrere Heteroatome aus der Gruppe O, N und S enthält, bilden, und
in der Z aus der Reihe O oder NR_a stammt, wobei R_a aus der folgenden Gruppe stammt:

(e) Phenyl;
(f) (O)C-O-R_b, wobei R_b ein geradkettiges oder verzweigtes C_1-C_6-Alkyl bedeutet;
(g) $-SO_2-R_c$, wobei R_c aus der folgenden Gruppe stammt:

i) geradkettiges oder verzweigtes C_1-C_6-Alkyl;
ii) $-(CH_2)_qR_e$, wobei q=0-3 und R_e ein C_3-C_6-Aryl, gegebenenfalls in einer oder mehreren Stellungen substituiert durch eine Gruppe aus der Reihe: Cl; F; NO_2; CN; I; Br; ein geradkettiges oder verzweigtes C_1-C_3-Alkyl; ein C_1-C_3-Alkoxy und $-C(O)R_f$, wobei R_f ein C_1-C_3-Alkyl bedeutet; $-(CH_2)_rCF_3$, wobei r=0-3, bedeutet;
iii) $-R_g(CF_3)_s$, wobei R_g ein geradkettiges oder verzweigtes C_1-C_3-Alkyl bedeutet und s=1-3;
iv) $-(CH_2)_s$-TMS, wobei TMS = Trimethylsilyl und s=1-3;

(h) $-SO_2-(CH_2)_q-Si(CH_3)_3$, wobei q 1-3 bedeutet.

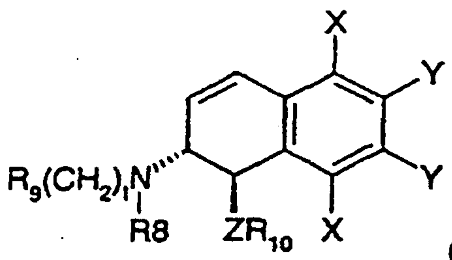
3. Verbindung der Formel III,



(III)

in der TBDMSO eine tert.-Butyldimethylsiloxygruppe bedeutet und R, X und Y wie in Anspruch 1 definiert sind.

4. Verbindung der Formel IV,



(IV)

in der

a) R_8 H oder CH_3 bedeutet oder wie in c) definiert ist;
b) t=0-3;
c) R_9 ein gegebenenfalls in einer oder mehreren Stellungen mit einer Gruppe aus der Reihe C_1-C_3-Alkyl, C_1-C_3-Alkoxy, Cl, F, NO_2 und CF_3 substituiertes C_3.C_6-Aryl bedeutet, oder R_9 gemeinsam mit N, R_8 und $(CH_2)_t$ der Formel IV eine Ringstruktur aus der Gruppe Phthalimidring, Pyrrolidinring, Piperidinring, Tetrahydrochinolinring und Indolring bildet, wobei diese Ringstruktur gegebenenfalls in einer oder mehreren Stellungen mit einer Gruppe aus der Reihe C_1-C_3-Alkyl, C_1-C_3-Alkoxy, Cl, F, NO_2 und CF_3 substituiert ist;
d) X und Y unabhängig aus der Gruppe H, NH_2, F, Cl, Br, C_1-C_3-Alkyl und C_1-C_3-Alkoxy stammen, oder benachbarte X und Y oder Y und Y gemeinsam mit den Kohlenstoffatomen, an die sie gebunden sind, einen C_3-C_6-Carbocyclus oder einen C_3-C_6-Heterocyclus, der ein oder mehrere Heteroatome aus der Gruppe O, N und S enthält, bilden;
e) Z aus der Reihe O oder NR_a stammt, wobei R_a aus der folgenden Gruppe stammt:

(i) geradkettiges oder verzweigtes C_1-C_6-Alkyl;
(ii) Phenyl;
(iii) (O)C-O-R_b, wobei R_b geradkettiges oder verzweigtes C_1-C_6-Alkyl bedeutet;
(iv) -SO_2-R_c, wobei R_c unsubstituiertes Phenyl oder Phenyl, das durch ein C_1-C_3-Alkyl oder NO_2 substituiert ist, bedeutet; und
(v) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$, wobei q 1-3 bedeutet;

f) R_{10} H bedeutet, wenn Z O bedeutet; und R_{10} entweder H oder CH_3 bedeutet, wenn Z NR_a bedeutet.

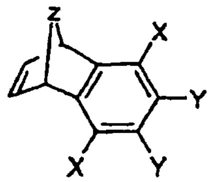
5. Verbindung nach einem der Ansprüche 1-4, wobei X=H und Y=H.

6. Verbindung die aus der folgenden Gruppe stammt:

(1S,2S)-2-Methoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(Ethoxy)-1,2-dihydronaphthalen-1-ol;/
(1S,2S)-2-(Isopropoxy)-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(Propenyloxy)-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(2-Trimethylsilyl-ethoxy)-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-Benzyloxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-4-Methoxybenzyloxy)-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(2,2,2-Trifluorethoxy)-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(2,2,2-Trifluor-1-trifluormethylethoxy)-1,2-dihydronaphthalen-1-ol;
(1S,2S)-6,7-Difluor-2-methoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-6-Methoxy-5,6-dihydronaphthol[2,3-d][1,3]-dioxol-5-ol;
(1S,2S)-6,7-Dibrom-2-methoxy-5,8-dimethyl-1,2-dihydronaphthalen-1-ol;
(1S*,2S*)-Essigsäure-1-hydroxy-1,2-dihydronaphthalen-2-yl-ester;
(1S*,2S*)-Propionsäure-1-hydroxy-1,2-dihydronaphthalen-2-yl-ester;
(1R,2R)-Benzoesäure-1-hydroxy-1,2-dihydronaphthalen-2-yl-ester;
(1R,2R)-Ameisensäure-1-hydroxy-1,2-dihydronaphthalen-2-yl-ester;
(1R,2R)-2-Methylacrylsäure-1-hydroxy-1,2-dihydronaphthalen-2-yl-ester;
(1R,2R)-Malonsäureethylester-(1-hydroxy-1,2-dihydronaphthalen-2-yl)ester;

(1R,2R)-Malonsäure-(1-tert.-butylbimethylsiloxy-1,2-dihydronaphthalen-2-yl)ethylester;
(1S*,2S*)-4-tert.-Butyldimethylsiloxy-1,4-dihydronaphthalen-2-yl)-essigsäureethylester;
(1R,2R)-2-(1-Hydroxy-1,2-dihydronaphthalen-2-yl)-isoindol-1,3-dion;
(1S,2S)-N-(1-Hydroxy-1,2-dihydronaphthalen-2-yl)-benzolsulfonamid;
(1R*,2R*)-2-Pyrrolidin-1-yl-1,2-dihydronaphthalen-1-ol;
(1R*,2R*)-2-Piperidin-1-yl-1,2-dihydronaphthalen-1-ol;
(1R,2R)-2-(3,4-Dihydro-2H-chinolin-1-yl)-1,2-dihydronaphthalen-1-ol;
(1R,2R)-2-(Methylphenylamino)-1,2-dihydronaphthalen-1-ol;
(1R*,2R*)-2-Benzylamino-1,2-dihydronaphthalen-1-ol;
(1R*,2R*)-2-(4-Methoxybenzylamino-1,2-dihydronaphthalen-1-ol;
(1R,2R)-2-Indol-1-yl-1,2-dihydronaphthalen-1-ol;
(1S*,2R*)-2-(Hydroxy-1,2-dihydronaphthalen-2-yl)-malonsäuredimethylester;
(1S,2S)-2-Phenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Nitrophenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Cyanophenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Acylphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Trifluormethylphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Fluorphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Chlorphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Iodphenoxy-1,2-dihydronaphthalen-1-ol;
(1R,2R)-2-(4-Bromphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Methylphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(4-Methoxyphenoxy-1,2-dihydronaphthalen-1-ol;
(1S,2S)-2-(2-Bromphenoxy-1,2-dihydronaphthalen-1-ol;
4-Methyl-N-[(1R,2S)-2-(1-piperidinyl)-1,2-dihydro-1-naphthalenyl]benzolsulfonamid;
N-[(1R,2S)-2-(3,4-Dihydro-1(2H)-chinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzolsulfonamid;
N-[(1R,2S)-2-(3,4-Dihydro-2(1H)-isochinolinyl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzolsulfonamid;
N-[(1R,2S)-2-(1H-indol-1-yl)-1,2-dihydro-1-naphthalenyl]-4-methylbenzolsulfonamid;
(1R,2S)-2-Methoxy-N-phenyl-1,2-dihydro-1-napthalenamin;
tert.-Butyl(1R,2S)-2-methoxy-1,2-dihydro-1-naphthalencarbamat;
N-[(1R,2S)-2-Methoxy-1,2-dihydro-1-naphthalenyl]-2-(trimethylsilyl)ethansulfonamid;
N,4-Dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenyl]benzolsulfonamid;
N,4-Dimethyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]benzolsulfonamid;
N-Hydroxy-4-({methyl[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenylamino)sulfonyl)-N-oxobenzolaminium;
N-Methyl-4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]benzolsulfonamid;
(1R,2S)-N-Methyl-2-(1-pyrrolidinyl)-1,2,3,4-tetrahydro-1-naphthalenamin;
N-[(1R,2S)-2-Methoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzolsulfonamid;
N-[(1R,2S)-2-Methoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzolsulfonamid;
4-Methyl-N-[(1R,2S)-2-phenoxy-1,2,3,4-tetrahydro-1-naphthalenyl]-4-methylbenzolsulfonamid;
(1R,2S)-1-{[(4-Methylphenyl)sulfonyl]amino)-1,2,3,4-tetrahydro-1-naphthalenylacetat;
(1R,2S)-1-{[(4-Methylphenyl)sulfonyl]amino)-1,2-dihydro-1-naphthalenylbenzoat;
(1R,2S)-1-{[(4-Methylphenyl)sulfonyl]amino)-1,2-dihydro-2-naphthalenylpivalat;
N-[(1R,2S)-2-Methoxy-1,2-dihydro-1-naphthalenyl]-2-(trimethylsilyl)ethansulfonamid;
tert.-Butyl(1R,2S)-2-methoxy-1,2-dihydro-1-naphthalenylcarbamat; und
4-Nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphthalenyl]benzolsulfonamid.

7. Verfahren zur Herstellung einer Verbindung der Formel I nach Anspruch 1, **dadurch gekennzeichnet, daß** man eine Verbindung der Formel ROH mit einer Verbindung der Formel V,

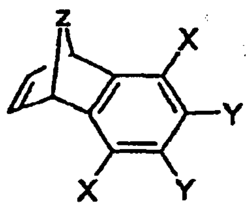


(V)

wobei R, X Y und Z wie in Anspruch 1 definiert sind, umsetzt, und wobei diese Reaktion durch $[Rh(COD)Cl]_2$ in Gegenwart eines ersten chiralen Phosphinliganden katalysiert wird.

8. Verfahren nach Anspruch 7, wobei der erste chirale Phosphinligand aus der Gruppe DPPF, (R)-(S)-BPPFA und (R)-(S)-PPF-P^tBu_2 stammt.

9. Verfahren zur Herstellung einer Verbindung der Formel II nach Anspruch 2, **dadurch gekennzeichnet, daß** man eine Verbindung der Formel ROH mit einer Verbindung der Formel V,



(V)

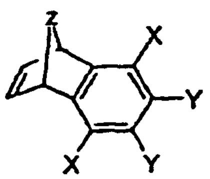
wobei R, X, Y und Z wie in Anspruch 3 definiert sind, umsetzt, und wobei diese Reaktion durch $[Rh(COD)Cl]_2$ in Gegenwart eines zweiten chiralen Phosphinliganden katalysiert wird.

10. Verfahren nach Anspruch 9, wobei es sich bei dem zweiten chiralen Phosphinliganden um (S)-(R)-PPF-P^tBu_2 handelt.

11. Verfahren zur Herstellung einer Verbindung der Formel III nach Anspruch 3, **dadurch gekennzeichnet, daß** man

(a) eine Verbindung der Formel I nach dem Verfahren nach Anspruch 7 herstellt; und
(b) die in Schritt (a) gebildete Verbindung mit einem Salz der tert.-Butyldimethylsilylsäure umsetzt.

12. Verfahren zur Herstellung einer Verbindung der Formel IV nach Anspruch 4, **dadurch gekennzeichnet, daß** man eine Verbindung der Formel R_9-$(CH_2)_t$$NHR_8$ mit einer Verbindung der Formel V,



(V)

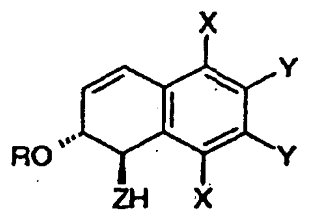
in der R_8, R_9, t, X, Y und Z wie in Anspruch 4 definiert sind, umsetzt, wobei diese Reaktion durch $[Rh(COD)Cl]_2$ in Gegenwart eines zweiten chiralen Phosphinliganden katalysiert wird.

13. Verfahren nach Anspruch 12, wobei der chirale Phosphinligand aus der Gruppe DPPF, (R)-(S)-BPPFA und (R)-(S)-PPF-P^tBu_2 stammt.

14. Verfahren nach Anspruch 13, wobei R_9 gemeinsam mit N einen Ring aus der Gruppe Phthalamidring, Pyrrolidinring, Piperidinring, Tetrahydrochinolinring und Indolring bildet, wobei diese Ringstruktur gegebenenfalls an einer oder mehreren Stellungen durch eine Gruppe aus der Reihe C_1-C_3-Alkyl, C_1-C_3-Alkoxy, Cl, F, NO_2 und CF_3 substituiert ist.

Revendications

1. Composé selon la formule I :



(I)

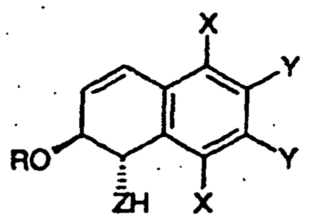
R est -$(CH_2)_nR_1$ et R_1 est un aryle en C_3-C_6 éventuellement substitué en une ou plusieurs positions par un groupement choisi parmi : Cl ; F ; NO_2 ; I ; Br ; un alkyle en C_1-C_3 ; et un alcoxy en C_1-C_3 et où n = 0 - 3 ;
dans laquelle X et Y sont choisis indépendamment dans le groupe constitué de H ; NH_2 ; F ; Cl ; Br ; un alkyle en C_1-C_3 ; et un alcoxy en C_1-C_3 ;
ou dans laquelle le X et le Y ou le Y et le Y adjacents conjointement avec les atomes de carbone auxquels ils sont liés forment un cycle carbocyclique en C_3-C_6 ou un cycle hétérocyclique en C_3-C_6 contenant un ou plusieurs hétéroatomes choisis dans le groupe constitué de : O ; N ; et S ; et
dans laquelle Z est choisi parmi O ou NR_a, où R_a est choisi parmi :

(i) phényle ;
(j) (O)C-O-R_b, où R_b est un alkyle en C_1-C_6 droit ou ramifié ;
(k) -SO_2-R_c, où R_c est choisi dans le groupe constitué de :

(i) alkyle en C_1-C_6 droit ou ramifié ;
(ii) -$(CH_2)_qR_e$, où q = 0 - 3 et R_e est un aryle en C_3-C_6, éventuellement substitué en une ou plusieurs positions par un groupement choisi parmi : Cl ; F ; NO_2 ; CN ; I ; Br ; un alkyle en C_1-C_3 droit ou ramifié ; un alcoxy en C_1-C_3 et -C(O)R_f, où R_f est un alkyle en C_1-C_3 ; -$(CH_2)_rCF_3$, où r = 0 - 3 ;
(iii) -$R_g(CF_3)_s$, où R_g est un alkyle en C_1-C_3 droit ou ramifié et s = 1 - 3 ;
(iv) -$(CH_2)_s$-TMS, où TMS = triméthylsilyle et s = 1 - 3 ;

(l) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ où q est 1 - 3.

2. Composé selon la formule II :



(II)

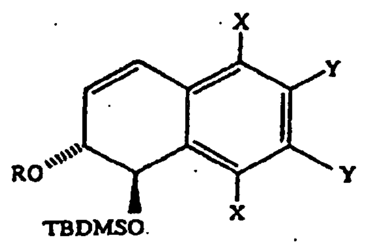
dans laquelle R est $-(CH_2)_qR_5$ où q = 0 - 3 et R_5 est un aryle en C_3-C_6 éventuellement substitué en une ou plusieurs positions par un groupement choisi parmi : un alkyle en C_1-C_3 droit ou ramifié ; un alcoxy en C_1-C_3 ; I ; Cl ; CN ; F ; NO_2 ; $-(CH_2)_rCF_3$, où r = 0 - 3 ; et $-C(O)R_6$, où R_6 est un alkyle en C_1-C_3 ;
dans laquelle X et Y sont choisis indépendamment dans le groupe constitué de H ; NH_2 ; F ; Cl ; Br ; un alkyle en C_1-C_3 ; et un alcoxy en C_1-C_3 ;
ou dans laquelle le X et le Y ou le Y et le Y adjacents conjointement avec les atomes de carbone auxquels ils sont liés forment un cycle carbocyclique en C_3-C_6 ou un cycle hétérocyclique en C_3-C_6 contenant un ou plusieurs hétéroatomes choisis dans le groupe constitué de : O ; N ; et S ; et
dans laquelle Z est choisi parmi O ou NR_a, où R_a est choisi parmi :

(e) phényle ;
(f) $(O)C$-O-R_b, où R_b est un alkyle en C_1-C_6 droit ou ramifié ;
(g) $-SO_2$-R_c, où R_c est choisi dans le groupe constitué de :

i) alkyle en C_1-C_6 droit ou ramifié ;
ii) $-(CH_2)_qR_e$, où q = 0 - 3 et R_e est un aryle en C_3-C_6, éventuellement substitué en une ou plusieurs positions par un groupement choisi parmi : Cl ; F ; NO_2 ; CN ; I ; Br ; un alkyle en C_1-C_3 droit ou ramifié ; un alcoxy en C_1-C_3 et $-C(O)R_f$, où R_f est un alkyle en C_1-C_3 ; $-(CH_2)_rCF_3$, où r = 0 - 3 ;
iii) $-R_g(CF_3)_s$, où R_g est un alkyle en C_1-C_3 droit ou ramifié et s = 1 - 3 ;
iv) $-(CH_2)_s$-TMS, où TMS = triméthylsilyle et s = 1 - 3 ;

(h) $-SO_2$-$(CH_2)_q$-$Si(CH_3)_3$ où q est 1 - 3.

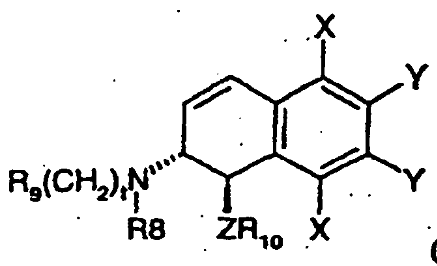
3. Composé selon la formule III :



(III)

dans laquelle TBDMSO est un groupement tert-butyldiméthylsiloxy, et R, X et Y sont tels que définis dans la revendication 1.

4. Composé selon la formule IV :



(IV)

dans laquelle :

a) R_8 est H, CH_3 ou tel que défini en c) ;
b) t = 0 - 3 ;

c) R_9 est un aryle en C_3-C_6 éventuellement substitué en une ou plusieurs positions par un groupement choisi parmi : un alkyle en C_1-C_3 ; un alcoxy en C_1-C_3 ; Cl ; F ; NO_2 ; et CF_3 ; ou R_9 conjointement avec N, R_8 et $(CH_2)_t$ de formule IV forme une structure cyclique choisie parmi : un cycle phtalamide ; un cycle pyrrolidine ; un cycle pipéridine ; un cycle tétrahydroquinoléine ; et un cycle indole ; ladite structure cyclique étant éventuellement substituée en une ou plusieurs positions par un groupement choisi parmi : un alkyle en C_1-C_3 ; un alcoxy en C_1-C_3 ; Cl ; F ; NO_2 ; et CF_3 ;
d) X et Y sont choisis indépendamment dans le groupe constitué de H ; NH_2 ; F ; Cl ; Br ; un alkyle en C_1-C_3 ; et un alcoxy en C_1-C_3 ; ou dans laquelle le X et le Y ou le Y et le Y adjacents conjointement avec les atomes de carbone auxquels ils sont liés forment un cycle carbocyclique en C_3-C_6 ou un cycle hétérocyclique en C_3-C_6 contenant un ou plusieurs hétéroatomes choisis dans le groupe constitué de : O ; N ; et S ;
e) Z est choisi parmi O ou NR_a, où R_a est choisi parmi :

(i) un alkyle en C_1-C_6 droit ou ramifié ;
(ii) phényle ;
(iii) (O)C-O-R_b, où R_b est un alkyle en C_1-C_6 droit ou ramifié ;
(iv) -SO_2-R_c, où R_c est un phényle non substitué ou un phényle substitué par un alkyle en C_1-C_3 ou NO_2 ; et
(v) -SO_2-$(CH_2)_q$-$Si(CH_3)_3$ où q est 1 - 3 ; et

f) lorsque Z est O, R_{10} est H ; lorsque Z est NR_a, R_{10} est soit H ou CH_3.

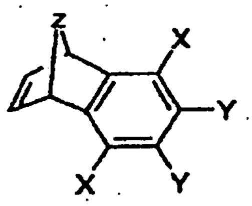
5. Composé selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** X = H et Y = H.

6. Composé choisi dans le groupe constitué de :

(1S,2S)-2-méthoxy-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(éthoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(isopropoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(1-propényloxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(2-triméthylsilyléthoxy)-1,2-dihydro-naphtalén-1-ol ;
(1S,2S)-2-benzyloxy-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-méthoxybenzyloxy)-1,2-dihydro-naphtalén-1-ol ;
(1S,2S)-2-(2,2,2-trifluoroéthoxy)-1,2-dihydro-naphtalén-1-ol ;
(1S,2S)-2-(2,2,2-trifluoro-1-trifluorométhyléthoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-6,7-difluoro-2-méthoxy-1,2-dihydro-naphtalén-1-ol ;
(1S,2S)-6-méthoxy-5,6-dihydronaphtol[2,3-d]-[1,3]dioxol-5-ol ;
(1S,2S)-6,7-dibromo-2-méthoxy-5,8-diméthyl-1,2-dihydronaghtalén-1-ol ;
ester de (1R*,2R*)-1-hydroxy-1,2-dihydronaphtalén-2-yle d'acide acétique ;
ester de (1R*,2R*)-1-hydroxy-1,2-dihydronaphtalén-2-yle d'acide propionique ;
ester de (1R,2R)-1-hydroxy-1,2-dihydronaphtalén-2-yle d'acide benzoïque ;
ester de (1R*,2R*)-1-hydroxy-1,2-dihydronaphtalén-2-yle d'acide formique ;
ester de (1R*,2R*)-1-hydroxy-1,2-dihydronaphtalén-2-yle d'acide 2-méthacrylique ;
ester de (1R*,2R*)-1-hydroxy-1,2-dihydronaphtalén-2-yle d'ester éthylique d'acide malonique ;
ester de (1R*,2R*)-1-tert-butyldiméthylsiloxy-1,2-dihydronaphtalén-2-yle d'ester éthylique d'acide malonique ;
ester éthylique d'acide (1S*,2S*)(4-tert-butyldiméthylsiloxy-1,4-dihydronaphtalén-2-yl)-acétique ;
(1R,2R)-2-(1-hydroxy-1,2-dihydronaphtalén-2-yl)-isoindole-1,3-dione ;
(1S,2S)-N-(1-hydroxy-1,2-dihydronaphtalén-2-yl)-benzènesulfonamide ;
(1R*,2R*)-2-pyrrolidin-1-yl-1,2-dihydronaphtalén-1-ol ;
(1R*,2R*)-2-pipéridin-1-yl-1,2-dihydronaphtalén-1-ol ;
(1R,2R)-2-(3,4-dihydro-2H-quinoléin-1-yl)-1,2-dihydronaphtalén-1-ol ;
(1R,2R)-2-(méthylphénylamino)-1,2-dihydronaphtalén-1-ol ;
(1R*,2R*)-2-benzylamino-1,2-dihydronaphtalén-1-ol ;
(1R*,2R*)-2-(4-méthoxybenzylamino)-1,2-dihydro-naphtalén-1-ol ;
(1R,2R)-2-indol-1-yl-1,2-dihydronaphtalén-1-ol ;
ester diméthylique d'acide (1S*,2R*)-2-(1-hydroxy-1,2-dihydronaphtalén-2-yl)malonique ;
(1S,2S)-2-phénoxy-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-nitrophénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-cyanophénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-acylphénoxy)-1,2-dihydronaphtalén-1-ol ;

(1S,2S)-2-(4-trifluorométhylphénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-fluorophénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-chlorophénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-iodophénoxy)-1,2-dihydronaphtalén-1-ol ;
(1R,2R)-2-(4-bromophénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-méthylphénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(4-méthoxyphénoxy)-1,2-dihydronaphtalén-1-ol ;
(1S,2S)-2-(2-bromophénoxy)-1,2-dihydronaphtalén-1-ol ;
4-méthyl-N-[(1R,2S)-2-(1-pipéridinyl)-1,2-dihydro-1-naphtalényl]benzènesulfonamide ;
N-[(1R,2S)-2-(3,4-dihydro-1(2H)-quinoléinyl)-1,2-dihydro-1-naphtalényl]-4-méthylbenzènesulfonamide ;
N-[(1R,2S)-2-(3,4-dihydro-2(1H)-isoquinoléinyl)-1,2-dihydro-1-naphtalényl]-4-méthylbenzène-sulfonamide ;
N-[(1R,2S)-2-(1H-indol-1-yl)-1,2-dihydro-1-naphtalényl]-4-méthylbenzènesulfonamide ;
(1R,2S)-2-méthoxy-N-phényl-2,2-dihydro-1-naphtalénamine ;
(1R,2S)-2-méthoxy-2,2-dihydro-1-naphtalénylcarbamate de tert-butyle ;
N-[(1R,2S)-2-méthoxy-1,2-dihydro-1-naphtalényl]-2-(triméthylsilyl)éthanesulfonamide ;
N-4-diméthyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2,3,4-tétrahydro-1-naphtalényl]benzènesulfonamide ;
N-4-diméthyl-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphtalényl]benzènesulfonamide ;
N-hydroxy-4-({méthyl[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphtalénylamino}sulfonyl)-N-oxobenzénaminium ;
N-méthyl-4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphtalényl]benzènesulfonamidé ;
(1R,2S)-N-méthyl-2-(1-pyrrolidinyl)-1,2,3,4-tétrahydro-1-naphtalénamine ;
N-[(1R,2S)-2-méthoxy-1,2,3,4-tétrahydro-1-naphtalényl]-4-méthylbenzènesulfonamide ;
N-[(1R,2S)-2-méthoxy-1,2,3,4-tétrahydro-1-naphtalényl]-4-méthylbenzènesulfonamide ;
4-méthyl-N-[(1R,2S)-2-phénoxy-1,2,3,4-tétrahydro-1-naphtalényl]benzènesulfonamide ;
acétate de (1R,2S)-1-{[(4-méthylphényl)sulfonyl]-amino}-1,2,3,4-tétrahydro-2-naphtalényle ;
benzoate de (1R,2S)-1-{[(4-méthylphényl)sulfonyl]-amino}-1,2-dihydro-2-naphtalényle ;
pivalate de (1R,2S)-1-{[(4-méthylphényl)sulfonyl]-amino}-1,2-dihydro-2-naphtalényle ;
N-[(1R,2S)-2-méthoxy-1,2-dihydro-1-naphtalényl]-2-(triméthylsilyl)éthanesulfonamide ;
(1R,2S)-2-méthoxy-1,2-dihydro-1-naphtalénylcarbamate de tert-butyle ; et
4-nitro-N-[(1R,2S)-2-(1-pyrrolidinyl)-1,2-dihydro-1-naphtalényl]benzènesulfonamide.

7. Procédé de préparation d'un composé selon la formule I de la revendication 1, comprenant la réaction d'un composé de formule ROH avec un composé de formule V :

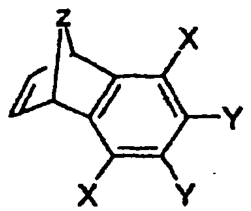


(V)

dans laquelle R, X, Y et Z sont tels que définis dans la revendication 1 ;
et dans laquelle ladite réaction est catalysée par $[Rh(COD)Cl]_2$ en présence d'un premier ligand phosphine chiral.

8. Procédé de la revendication 7, **caractérisé en ce que** le premier ligand phosphine chiral est choisi dans le groupe constitué de : DPPF ; (R)-(S)-BPPFA ; et (R)-(S)-PPF-P^{t}Bu$_2$.

9. Procédé de préparation d'un composé selon la formule II de la revendication 2, comprenant la réaction d'un composé de formule ROH avec un composé de formule V :



(V)

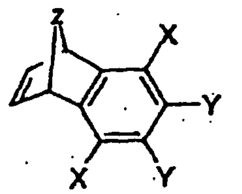
dans laquelle R, X, Y et Z sont tels que définis dans la revendication 3 ;
et où ladite réaction est catalysée par. $[Rh(COD)Cl]_2$ en présence d'un deuxième ligand phosphine chiral.

10. Procédé de la revendication 9, **caractérisé en ce que** ledit deuxième ligand phosphine chiral est (S)-(R) -PPF-P^tBu_2.

11. Procédé de préparation d'un composé selon la formule III de la revendication 3, comprenant :

(a) la préparation d'un composé de formule I selon le procédé de la revendication 7 ; et
(b) la réaction du composé formé dans l'étape (a) avec un sel d'acide tert-butyldiméthylsilylique.

12. Procédé de préparation d'un composé de formule IV selon la revendication 4, comprenant la réaction d'un composé de formule R_9-$(CH_2)_t$$NHR_8$ avec un composé de formule V



(V)

dans laquelle R_8, R_9, t, X, Y et Z sont tels que définis dans la revendication 4, et où ladite réaction est catalysée par $[Rh(COD)Cl]_2$ en présence d'un ligand phosphine chiral.

13. Procédé de la revendication 12, **caractérisé en ce que** ledit ligand phosphine chiral est choisi dans le groupe constitué de : DPPF ; (R)-(S)-BPPFA ; et (R)-(S)-PPF-P^t-Bu_2.

14. Procédé de la revendication 13, **caractérisé en ce que** R_9 conjointement avec N forment un cycle choisi dans le groupe constitué de : un cycle phtalamide ; un cycle pyrrolidine ; un cycle pipéridine ; un cycle tétrahydroquinoléine ; et un cycle indole ; ladite structure cyclique étant éventuellement substituée en une ou plusieurs positions par un groupement choisi parmi : un alkyle en C_1-C_3 ; un alcoxy en C_1-C_3 ; Cl ; F ; NO_2 ; et CF_3.