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(54) Title: PROCESS FOR PRODUCING INDENOL ESTERS OR ETHERS

(57) Abstract: The present invention relates to a process for making indenol esters or ether from an α -substituted cinnamic aldehyde derivative such as an acetal or an acylal. Said reaction is promoted by the use of strong mineral acids, sulphonic acids, acidic zeolites or Lewis acids.



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PROCESS FOR PRODUCING INDENOL ESTERS OR ETHERS

Technical field

The present invention relates to the field of organic synthesis. More particularly it provides a process for making an indenol ester or ether from an α -substituted cinnamic aldehyde derivative such as an acyclic acetal or an acylal. Said reaction is promoted by the use of strong mineral acids, sulphonic acids, acidic zeolites or Lewis acids.

Prior art

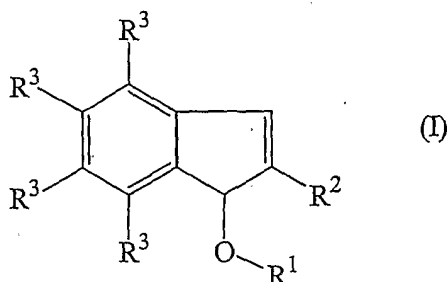
The compounds of formula (I), as defined below, can be useful as perfuming ingredients and/or as starting material for the synthesis of compounds having a more complex skeleton.

The methods of preparation of said compounds reported in the prior art are in general quite long and/or expensive.

It is therefore highly desirable to access such compounds by means of a simple and efficient isomerisation process wherein the starting material is an easily accessible material. To the best of our knowledge, in the prior art there is no report of an isomerisation process giving a direct access to compounds of formula (I) from the compound of formula (II).

Description of the invention

In order to solve the problems aforementioned, a first embodiment of the present invention provides a process for making a compound of formula

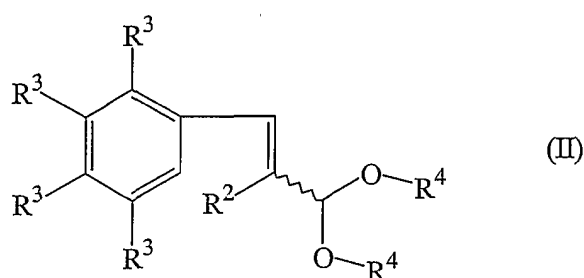


wherein R^1 represents a formyl group, a $-\text{COCOOH}$ group or a group of formula $-(\text{CO})_n\text{-R}$, n being 0 or 1 and R representing an optionally substituted phenyl group or a C_{1-6} alkyl or alkenyl group optionally halogenated;

R^2 represents a C_{1-10} alkyl or alkenyl group; and

5 at least one R^3 represents a hydrogen atom and the other R^3 represent each a hydrogen atom or a C_{1-5} alkyl, alkenyl or alkoxy group;

comprising the cyclisation, at a temperature above 10°C , of the corresponding compound of formula



10

wherein each R^4 , taken separately, represents a formyl group or a $-(\text{CO})_n\text{-R}$ group, or the R^4 , taken together, represent a $-\text{COCO}-$ group;

the wavy line indicates that the configuration of the carbon-carbon double bond is E or Z or a mixture thereof; and

15 n , R , R^2 , R^3 and R^4 have the meaning as indicated above;

in the presence of a compound, which promotes the reaction, selected from the group consisting of strong mineral protic acids, sulphonic acids, acidic zeolites and Lewis acids.

20 Examples of the substituent of R , when it is a phenyl, are one or two halogen atoms, C_{1-5} alkyl or alkoxy or C_{0-6} amino groups. Examples of halogens for R are chlorine or fluorine atoms.

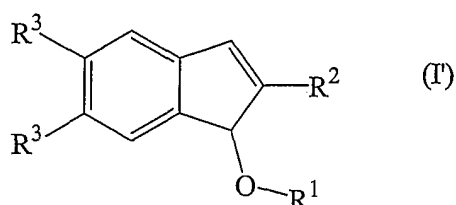
For the invention purpose, it is important that R^2 is not a hydrogen atom, indeed if R^2 is H then the reaction does not take place.

25 According to an embodiment of the present invention R^1 represents a group of formula $-(\text{CO})_n\text{-R}$, n being 0 or 1 and R representing an optionally substituted phenyl group or a C_{1-5} alkyl group.

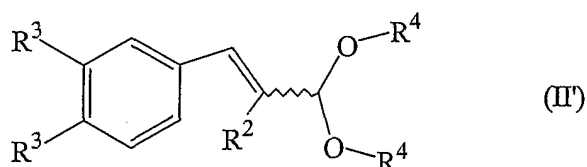
According to another embodiment of the present invention, R^2 represents a C_{1-6} alkyl group.

According to a further embodiment of the present invention, at least two R^3 represent a hydrogen atom and the other R^3 may represent each a hydrogen atom or a C_{1-5} alkyl or alkoxy group.

According to a particular embodiment of the invention the compounds of formula (I) are of formula



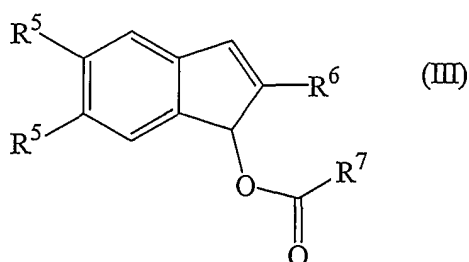
and are obtained by cyclisation of the corresponding compounds of formula



wherein the wavy line R^1 , R^2 and R^4 have the same meaning as indicated above, and one R^3 is a hydrogen atom and the other R^3 is a C_{1-5} alkyl group

The compounds of formula (I') wherein one R^3 is a hydrogen atom and the other R^3 is a C_{1-5} alkyl group are new compounds and can be used as starting compounds for the synthesis of indenols. Amongst said compounds of formula (I') can be cited the ones wherein R^2 is a methyl group and both R^3 are hydrogen atoms or the ones wherein R^2 is a methyl group and one R^3 is a hydrogen atom and the other R^3 is a methyl group.

Amongst the compounds of formula (I'), those of formula



wherein one R^5 is a hydrogen atom and the other R^5 is a C_{1-5} alkyl group and R^6 or R^7 represents a methyl or ethyl group;

are also new and can be used as perfuming ingredient to impart floral and/or indole odor notes.

5 For example, one may cite 2,6-dimethyl-1H-inden-1-yl acetate which possesses an odor of the muguet, acetophenone type with some cedar and indol connotations, or also 2,6-dimethyl-1H-inden-1-yl propanoate which has a floral-estery odor.

The compounds, which can be used in the invention's process to promote it, are a strong mineral protic acid, a suphonic acid, an acidic zeolite or a Lewis acid. By "mineral"
10 we mean here an acid having an anion which does not contain a carbon atom. By "strong" we mean here a protic acid having a $pK_{AB} < 3$, preferably below 2.

By "Lewis acid" we mean here an acid which is not essentially a protic acid. For example one may cite BF_3 and its adducts or Fe, Zn, Sn or Cd salts with weakly coordinating anions such as halides, sulphonates carboxylates or non-coordinating anion.

15 Said compounds can be in the anhydrous form or also in the hydrate form, except for those acids which are unstable in the presence of water.

According to another particular embodiment of the invention, the compound promoting the reaction is selected from the group consisting of H_2SO_4 , p-toluenesulphonic acid, $NaHSO_4$, $KHSO_4$, H_3PO_4 , HCl , HNO_3 , BF_3 and its adducts with
20 C_{2-6} ethers or with C_{2-6} carboxylic acids, poly(styrene sulphonic acid) based resins, K-10 Clay, SnX_4 , FeX_3 and ZnX_2 , ZnI_2 , X representing a halogen atom, such as Cl or Br, or a C_{1-6} carboxylate, such as acetate or trifluoroacetate, or a C_{1-7} sulphonate, such as a triflate or tosylate.

Preferably, the catalyst is H_3PO_4 , FeX_3 or ZnX_2 , and in particular $FeCl_3$ or $ZnCl_2$.

25 Said compounds can be added to the reaction medium in catalytic or stoichiometric amounts or even in excess. As non-limiting examples, one can cite catalytic amounts ranging from 0.001 to 0.50 molar equivalents, relative to the molar amount of the starting compound (II). Preferably, the catalyst concentrations will be comprised between 0.005 and 0.30, or even between 0.005 and 0.15, molar equivalents. It
30 goes without saying that the optimum concentration of catalyst will depend on the nature of the catalyst and on the desired reaction time.

Another parameter of the invention's process is the temperature. In order to allow the cyclisation to occur, it is useful to carry out the invention's process at a temperature of at least 10°C. Below said temperature the speed of the reaction decreases quite rapidly. The upper limit of temperature range is fixed by the reflux temperature of the reaction mixture that, as skilled persons know, depends on the exact nature of the starting and final product and optionally, as explained below, of the solvent. However, as non-limiting example, one can cite a preferred temperature ranging between 60°C and 180°C. Of course, a person skilled in the art is also able to select the preferred temperature as a function of the melting and boiling point of the starting and final products as well as of the solvent.

The process of the invention can be carried out in the presence or in the absence of solvent. As a person skilled in the art can anticipate, the presence of a solvent is mandatory only in the case in which the starting compound is a solid compound under the reaction conditions.

However, according to a preferred embodiment of the invention, and independently of the physical state of the starting compound, the process is advantageously carried out in the presence of a solvent. Preferably, said solvent is anhydrous or does not contain more than 5% w/w water.

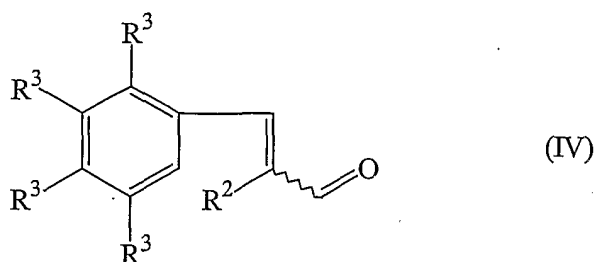
Non-limiting examples of such a solvent are C₄-C₈ ethers, C₃-C₆ esters, C₃-C₆ amides, C₆-C₉ aromatic solvents, C₅-C₇ linear or branched or cyclic hydrocarbons, C₁-C₂ chlorinated solvents and mixtures thereof.

Furthermore, the reaction can also be carried out in the presence of a solvent belonging to the family of orthoesters of formula (RO)₃CR or, and preferably, to the family of carboxylic anhydride of formula RC(O)O(O)CR, R being defined as above, optionally containing the corresponding carboxylic acid R⁸COOH.

The compound of formula (II) can be made and isolated according to any prior art method. Alternatively, compound (II) can be also generated *in situ*, i.e. in the reaction medium just before its use, according to any know prior art method.

In particular, preferably the compound of formula (II) is made or generated by a method using the corresponding enal as starting material. Indeed, the enal can be easily obtained by an aldol condensation, as a person skilled in the art knows well.

Therefore, another object of the present invention is an invention's process, as defined above, further comprising the step of generating *in situ* the compound of formula (II) starting from the corresponding enal of formula



wherein R^2 and R^3 have the same meaning indicated above.

A process comprising the *in situ* generation of the compound of formula (II) is particularly useful when said compound (II) is an acylal, i.e. a geminal dicarboxylate.

Now, when the compound of formula (II) is an acylal, we have also noticed that the compounds that are able to promote the cyclisation of the acylal are also useful to promote the conversion of the enal into the corresponding acylal.

Therefore, another object of the present invention, and in fact a particular embodiment of the above-mentioned process, is a process for making an ester of formula (I), as defined above, comprising the step of reacting, in the presence of a catalyst as defined for the cyclisation step, an enal of formula (IV), as defined above, with an orthoesters of formula $(RO)_3CR$ or, and preferably, a carboxylic anhydride of formula $RC(O)O(O)CR$, R being defined as above.

The invention will now be described in further detail by way of the following examples, wherein the abbreviations have the usual meaning in the art, the temperatures are indicated in degrees centigrade ($^{\circ}C$). The NMR spectral data were recorded in $CDCl_3$ at 400MHz or 100MHz for 1H or ^{13}C , respectively, the chemical displacements δ are indicated in ppm with respect to TMS as standard, and the coupling constants J are expressed in Hz. All the abbreviations have the usual meaning in the art.

Example 1Cyclisation of 2-alkylcinnamic aldehyde via the acylal derivative5 a) *Preparation of 2-pentyl-1H-inden-1-yl acetate*

4.13 ml of a 0.25 M solution of $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ in Ac_2O (1.03 mmol) were diluted into Ac_2O (30.2 g) and the resulting solution was added dropwise during 1 hour to a stirred solution of 2-pentylcinnamaldehyde (20 g, 99 mmol) in AcOH (18.5 g) at reflux.

After a further 2 hours at reflux the cooled mixture was poured into a mixture of H_2O and Et_2O . Then, solid Na_2CO_3 (44.7 g) was added portionwise to the stirred mixture. After one hour stirring the aqueous phase was saturated with NaCl and extracted with Et_2O . The organic layers were dried over anhydrous Na_2SO_4 , and the solvent evaporated to afford a crude product, which was further purified by distillation under vacuum to give the desired compound (yield = 87%).

15 B.p. 86-93°/0.05 mbar

$^1\text{H-NMR}$: 0.90(br.t, J=7, 3H); 1.35(4H); 1.58(m, 2H); 2.17(s, 3H); 2.29(m, 2H); 6.21(s, 1H); 6.43(s, 1H); 7.09(dd, J=7, J=7, 1H); 7.13(d, J=7, 1H); 7.23(m, 1H); 7.37(d, J=7, 1H)

$^{13}\text{C-NMR}$: 171.4(s); 149.2(s); 143.7(s); 142.0(s); 128.9(d); 128.2(d); 125.1(d); 124.2(d); 120.4(d); 77.5(d); 31.6(t); 28.2(t); 27.7(t); 22.5(t); 21.1(q); 14.0(q)

20 b) *Preparation of 2-hexyl-1H-inden-1-yl acetate*

Using the same experimental procedure as under a), 2-hexylcinnamaldehyde (20 g, 92.6 mmol), $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ (3.85 ml of a 0.25 M solution in Ac_2O , 0.96 mmol), Ac_2O (28.3 g, 0.28 mol) in AcOH (17.4 g) were reacted together. After a further 3 hours at reflux the cooled mixture was treated to the same workup as before to provide the title compound (yield = 83%)

25 B.p. 89-101° / 0.035 mbar

$^1\text{H-NMR}$: 0.89(t, J=7, 3H); 1.25-1.40(6H); 1.58(m, 2H); 2.17(s, 3H); 2.29(m, 2H); 6.21(s, 1H); 6.43(s, 1H); 7.09(dd, J=7, J=7, 1H); 7.13(d, J=7, 1H); 7.22(m, 1H); 7.36(d, J=7, 1H)

30

^{13}C -NMR: 171.4(s); 149.3(s); 143.7(s); 142.0(s); 128.9(d); 128.2(d); 125.1(d);
124.2(d); 120.4(d); 77.5(d); 31.7(t); 29.1(t); 28.3(t); 28.0(t); 22.6(t);
21.1(q); 14.1(q)

5 c) *Preparation of 2-methyl-1H-inden-1-yl acetate*

Using the same experimental procedure as under a), 2-methylcinnamaldehyde (21 g, 0.14 mol) in AcOH (27 g), $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ (6 ml of a 0.25 M solution in Ac_2O , 1.5 mmol) in Ac_2O (53 g) were reacted together. After a further 2 hours at reflux the cooled mixture was treated to the same workup and purification as before to provide the title
10 compound (yield = 70%)

B.p. 70-95°/0.04 mbar.

^1H -NMR: 1.98(s,3H); 2.18(s,3H); 6.15(s,1H); 6.41(s,1H); 7.09(dd,J=7, 7, 1H);
7.12(d,J=7,1H); 7.23(m,1H); 7.37(d,J=7,1H)

^{13}C -NMR: 171.5(s); 144.4(s); 143.7(s); 142.1(s); 129.3(d); 128.9(d); 125.1(d);
15 124.2(d); 120.3(d); 78.4(d); 21.1(q); 14.0(q)

Example 2

a) *Preparation of 1-methoxy-2-methyl-1H-indene via cyclisation of the acetal*

20 A solution of FeCl_3 anhydrous (42 mg, 0.25 mmol) in BuOAc (4 ml) was added dropwise during 10 minutes to a stirred solution of the 3,3-dimethoxy-2-methyl-1-phenyl-1-propene (5 g, 24.7 mmol) in BuOAc (13 ml) at 123° C. After 3 hours the cooled mixture was diluted with Et_2O (50 ml) and washed with saturated aqueous NaHCO_3 and brine. Extraction, drying over anhydrous Na_2SO_4 , concentration and
25 fractional distillation under vacuum gave a crude product that was further purified by chromatography (SiO_2 , cyclohexane/AcOEt 95:5 then AcOEt/ Et_2O 1:1). There was thus obtained the title compound with a yield of 33%.

B.p. 32-43°/0.07 mbar

^1H -NMR: 2.03(s,3H); 3.03(s,3H); 4.85(s,1H); 6.44(s,1H); 7.09(dd,J=7,J=7, 1H);
30 7.11(d,J=7,1H); 7.22(m,1H); 7.41(d,J=7,1H)

^{13}C -NMR: 145.9(s); 143.9(s); 141.8(s); 128.7(d); 128.4(d); 124.6(d); 123.7(d);
120.1(d); 84.9(d); 51.8(q); 14.1(q)

b) *Preparation of 2-methyl-1H-inden-1-yl acetate via cyclisation of the acylal*

A solution of FeCl₃ anhydrous (21 mg, 0.125 mmol) in BuOAc (2 ml) was added dropwise during 5 minutes to a stirred solution of the 2-methyl-3-phenyl-2-propenylidene diacetate (3.1 g, 12.5 mmol) in BuOAc (8 ml) at 123°. After 2 h at 123° the reaction was stopped and worked-up as above. Chromatography (SiO₂, cyclohex/AcOEt 9:1) of the crude product allowed the isolation of the title acetate (62% yield). Identical spectra as previously described.

10

Example 3

Synthesis of 2,6-dimethyl-1H-inden-1-yl acetate from the corresponding aldehyde

A solution of (2*E*)-2-methyl-3-(4-methylphenyl)-2-propenal (100.0 g, 0.62 mol) in cyclohexane (300.0 g) was added dropwise in 2 hours to a stirred solution of zinc chloride (3.1 g, 22 mmol) in acetic anhydride (188.4 g, 1.85 mol) at 80°C. The reaction mixture was stirred further at 80°C for 18 hours and then cooled to 25°C. The mixture was washed twice with water (100.0 g) and a 5% aqueous solution of sodium carbonate (100.0 g) and concentrated under reduced pressure. The crude product was flash-distilled (B.p.: 75-90°C / 0.1 mbar) affording 88.5 g of the desired acetate (69%) as a yellow liquid (purity: 97.1% GC).

¹H-NMR: 7.19 (s, 1H); 7.03 (d, J = 7.9, 1H); 6.99 (d, J = 7.9, 1H); 6.37 (s, 1H); 6.11 (s, 1H); 2.31 (s, 3 H); 2.17 (s, 3 H); 1.95 (s, 3 H).
¹³C-NMR: 171.5 (s); 143.3 (s); 142.3 (s); 141.0 (s); 134.8 (s); 129.2 (d); 125.2 (d); 120.0 (d); 78.4 (d); 21.3 (q); 21.1 (q); 14.0 (q).

25

Example 4

Synthesis of 2,6-dimethyl-1H-inden-1-yl acetate from the corresponding aldehyde

30

General procedure

A solution of (2*E*)-2-methyl-3-(4-methylphenyl)-2-propenal (100.0 g, 0.62 mol) in acetic anhydride (100.0 g) was added dropwise in 2 hours to a stirred solution of the catalyst in

acetic anhydride (88.4 g, 1.85 mol in total) at 80°C. The reaction mixture was stirred further at 80°C until the complete conversion of the starting material and then cooled to 25°C. The mixture was diluted with methyl *tert*-butyl ether (300.0 g), washed successively with water (twice 100.0 g) and a 5% aqueous solution of sodium carbonate (100.0 g) and concentrated under reduced pressure. The crude product was flash-distilled (B.p.: 75-90°C / 0.1 mbar) affording the desired acetate as a yellow liquid.

The results obtained are listed in the following table:

Catalyst	Reaction time	Isolated yield
H ₃ PO ₄ (0.072 eq.)	22 h.	51%
BF ₃ .OEt ₂ (0.036 eq.)	19 h.	37%
ZnBr ₂ (0.036 eq.)	5 h.	55%

eq. = molar equivalents in respect to the starting material h = hours

Example 5

Synthesis of 1-ethoxy-2-butyl-1H-indene from the corresponding aldehyde

A mixture of 2-butylcinnamic aldehyde (5 g, 26.7 mmol.), triethyl orthoformate (5.9 g, 40 mmol.), absolute ethanol (10 g, 217 mmol.) and Amberlyst® 15 (0.52 g) was heated at reflux (85°C oil bath). After three days, the mixture was filtered and concentrated under vacuum. The residue was subjected to silica gel flash chromatography (hexane/ethyl acetate 98:2), yielding 3.8 g (17.6 mmol., 66% yield) of the indenyl ethyl ether.

¹H-NMR: 0.95 (t, J=7.4, 3H), 1.15 (t, J=6.9, 3H), 1.46-1.36 (m, 2H), 1.70-1.50 (m, 2H), 2.45-2.30 (m, 2H), 3.27-3.15 (m, 2H), 4.95 (s, 1H), 6.41 (s, 1H), 7.1 (t, J=7.2, 1H), 7.13 (d, J=7.2, 1H), 7.21 (t, J=7.2, 1H), 7.42 (d, J=7.2, 1H).

¹³C-NMR: 14.0 (q), 15.7 (q), 22.7 (t), 28.1 (t), 30.5 (t), 60.0 (t), 83.4 (d), 120.2 (d), 123.7 (d), 124.6 (d), 126.9 (d), 128.3 (d), 142.5 (s), 143.6 (s), 151.3 (s).

Example 6

Synthesis of 2-ethyl-1H-inden-1-yl acetate

A mixture of (*E*)-2-ethylcinnamaldehyde (8 g, 50 mmol.) and acetic anhydride (7.7 g, 75 mmol.) was cooled in an ice bath. Anhydrous FeCl₃ (0.3 g, 1.8 mmol.) was added and the mixture stirred for 15 minutes. The reaction mixture was removed from the cold bath and stirred at room temperature for one day. It then was diluted with 100 ml of diethyl ether and washed with water (2 x 50 ml). The organic phase was dried (MgSO₄), filtered and concentrated. Kugelrohr distillation (95-105°C, 24 mTorr) yielded 8.0 g (39.6 mmol., 79% yield) of the title compound.

IR (film) ν_{co} 1738 cm⁻¹.

¹H-NMR: 1.19 (t, J=7.4 Hz, 3H); 2.16 (s, 3H); 2.32 (m, 2H); 6.22 (s, 1H); 6.43 (s, 1H); 7.08 (t, J=7 Hz, 1H); 7.13 (d, J=7 Hz, 1H); 7.22 (t, J=7 Hz, 1 H), 7.36 (d, J=7 Hz, 1 H).

¹³C-NMR: 12.3 (q); 21.1 (q); 21.5 (t); 77.6 (d); 120.5 (d); 124.2 (d); 125.1 (d); 127.4 (d); 128.9 (d); 142.0 (s); 143.6 (s); 150.7 (s); 171.5 (s).

Example 7

Synthesis of 2-isopropyl-1H-inden-1-yl acetate

A mixture of (*E*)-2-isopropylcinnamaldehyde (18 g, 103 mmol.) and acetic anhydride (15.9 g, 155 mmol.) was cooled in an ice bath. Anhydrous FeCl₃ (0.75 g, 4.6 mmol.) was added and the mixture stirred for 15 minutes. The reaction mixture was removed from the cold bath and stirred at room temperature for one day. It then was diluted with 100 ml of diethyl ether and washed with water (2 x 100 ml). The organic phase was dried (MgSO₄), filtered and concentrated. Kugelrohr distillation (93-104°C, 30 mTorr) yielded 18.2 g (84 mmol., 82% yield) of the title compound.

IR (film) ν_{co} 1739 cm⁻¹.

¹H-NMR: 1.15 (d, J=6.7 Hz, 3H); 1.23 (d, J=6.7 Hz, 3H); 2.17 (s, 3H); 2.59 (sp, J=6.7 Hz, 1H); 6.34 (s, 1H); 6.44 (s, 1H); 7.09 (t, J=7 Hz, 1H); 7.14 (d, J=7 Hz, 1H); 7.23 (t, J=7 Hz, 1H); 7.35 (d, J=7 Hz, 1H).

¹³C-NMR: 20.9 (q); 21.1 (q); 22.9 (q); 27.3 (d); 76.6 (d); 120.6 (d); 124.2 (d); 125.2 (d); 126.6 (d); 128.9 (d); 142.1 (s); 143.4 (s); 155.0 (s); 171.4 (s).

Example 8Synthesis of 1-ethoxy-2,6-dimethyl-1H-indene

5

Anhydrous FeCl₃ (2.0 g, 12.3 mmol.) was added to a solution of (2*E*)-2-methyl-3-(4-methylphenyl)-2-propenal (5.0 g, 31.3 mmol.) and triethyl orthoformate (5.1 g, 34.5 mmol.) in dichloromethane (35 ml). The dark red solution was stirred at room temperature for 1 day, then diluted with 100 ml of diethyl ether and washed with water (3
10 x 75 ml). The organic phase was dried (MgSO₄), filtered and concentrated. Kugelrohr distillation (54°C, 20 mTorr) yielded 1.4 g (7.4 mmol., 24% yield) of the title compound.
¹H-NMR: 1.66 (t, J=7, 3H); 2.01 (s, 3H); 2.34 (s, 3H); 3.22 (m, 2H); 4.84 (s, 1H); 6.36 (s, 1H); 7.0 (m, 2H); 7.24 (s, 1H).
¹³C-NMR: 14.1 (q); 15.7 (q); 21.4 (q); 59.9 (t); 84.4 (d); 119.7 (d); 124.7 (d); 128.0 (d);
15 128.7 (d); 134.2 (s); 141.0 (s); 142.9 (s); 145.3 (s).

Example 9Synthesis of 1-methoxy-2,6-dimethyl-1H-indene

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Anhydrous FeCl₃ (2.0 g, 12.3 mmol.) was added to a solution of (2*E*)-2-methyl-3-(4-methylphenyl)-2-propenal (5.0 g, 31.3 mmol.) and trimethyl orthoformate (36.4 g, 34.3 mmol.) in dichloromethane (35 ml). The dark red solution was stirred for one hour, then diluted with 100 ml of diethyl ether and washed with water (3 x 75 ml). The organic
25 phase was dried (MgSO₄), filtered and concentrated. Kugelrohr distillation (65-80°C, 20 mTorr) yielded 3.2 g (18.4 mmol., 59% yield) of the title compound.
¹H-NMR: 2.00 (s, 3H); 2.35 (s, 3H); 3.03 (s, 3H); 4.82 (s, 1H); 6.40 (s, 1H); 7.02 (m, 2H); 7.24 (s, 1H).
¹³C-NMR: 14.1 (q); 21.4 (q); 51.8 (q); 84.8 (d); 119.8 (d); 124.8 (d); 128.5 (d); 128.8 (d);
30 134.3 (s); 141.2 (s); 142.1 (s); 144.7 (s).

Example 10Synthesis of 2,6-dimethyl-1H-inden-1-yl propionate from the corresponding aldehyde

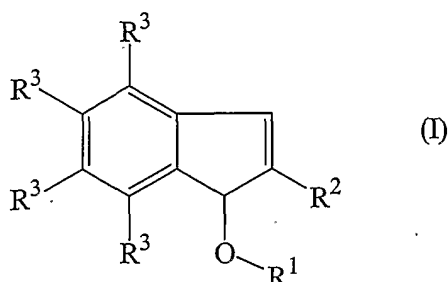
- 5 Same procedure as for the corresponding acetate (example 3) but using propionic anhydride instead of acetic anhydride. The crude product was distilled through a short Vigreux column (B.p.: 75-90°C / 0.1 mbar) affording 98.0 g of the desired propionate (71%) as a yellow liquid (purity: 97.3% GC).

¹H-NMR: 7.18 (s, 1H); 7.02 (d, J = 8.2, 1H); 6.99 (d, J = 8.2, 1H); 6.38 (s, 1H); 6.13 (s,
10 1H); 2.45 (q, J = 7.7, 2 H); 2.31 (s, 3 H); 1.95 (s, 3 H); 1.22 (t, J = 7.7, 3 H).

¹³C-NMR: 175.0 (s); 143.4 (s); 142.5 (s); 141.0 (s); 134.8 (s); 129.2 (d); 129.1 (d); 125.2 (d); 120.0 (d); 78.3 (d); 27.8 (t); 21.3 (q); 14.0 (q); 9.3 (q).

Claims

1. A process for making a compound of formula



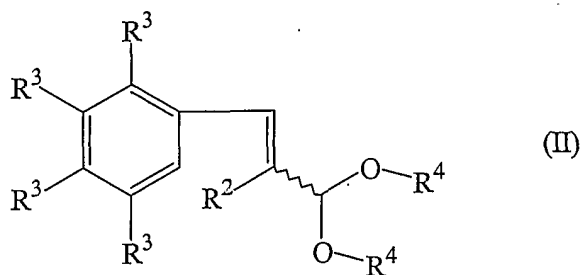
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wherein R^1 represents a formyl group, a $-\text{COCOOH}$ group or a group of formula $-(\text{CO})_n-\text{R}$, n being 0 or 1 and R representing an optionally substituted phenyl group or a C_{1-6} alkyl or alkenyl group optionally halogenated;

10 R^2 represents a C_{1-10} alkyl or alkenyl group; and

at least one R^3 represents a hydrogen atom and the other R^3 represent each a hydrogen atom or a C_{1-5} alkyl, alkenyl or alkoxy group;

comprising the cyclisation, at a temperature above 10°C , of the corresponding compound of formula



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wherein each R^4 , taken separately, represents a formyl group or a $-(\text{CO})_n-\text{R}$ group, or the R^4 , taken together, represent a $-\text{COCO}-$ group;

the wavy line indicates that the configuration of the carbon-carbon double bond is E or Z or a mixture thereof; and

20

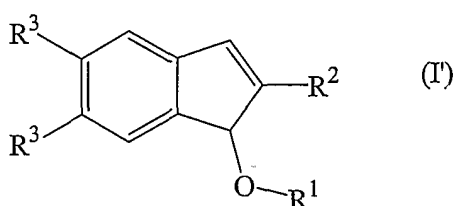
n , R , R^2 , R^3 and R^4 have the meaning as indicated above;

in the presence of a compound, which promote the reaction, selected from the group consisting of strong mineral protic acids, sulphonic acids, acidic zeolites and Lewis acids.

2. A process according to claim 1, characterized in that R^1 represents a group of formula $-(CO)_n-R$, n being 0 or 1 and R representing an optionally substituted phenyl group or a C_{1-5} alkyl group and R^2 represents a C_{1-6} alkyl group.

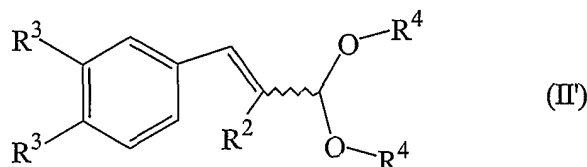
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3. A process according to claim 1, characterized in that the compounds of formula (I) are of formula



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and are obtained by cyclisation of the corresponding compounds of formula



15 wherein the wavy line R^1 , R^2 , R^3 and R^4 have the same meaning as in claim 1.

4. A process according to claim 1, characterized in that the compound, which promote the reaction, is selected from the group consisting of H_2SO_4 , p-toluenesulphonic acid, $NaHSO_4$, $KHSO_4$, H_3PO_4 , HCl , HNO_3 , BF_3 and its adducts with C_{2-6} ethers or with C_{2-6} carboxylic acids, poly(styrene sulphonic acid) based resins, K-10 Clay, SnX_4 , FeX_3 and ZnX_2 , ZnI_2 , X representing a halogen atom, such as Cl or Br , or a C_{1-6} carboxylate, such as acetate or trifluoroacetate, or a C_{1-7} sulphonate, such as a triflate or tosylate.

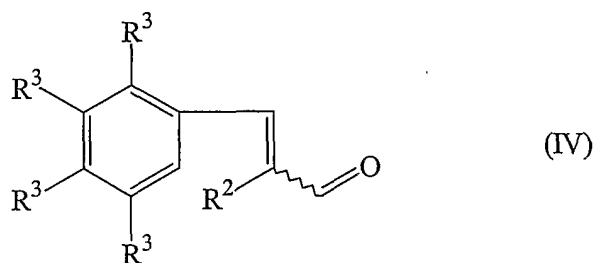
5. A process according to claim 4, characterized in that the compound is H_3PO_4 , FeX_3 or ZnX_2 , X having the same meaning as in claim 4.

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6. A process according to claim 1, characterized in that it is carried out in the presence of a carboxylic anhydride of formula $RC(O)O(O)CR$ or of an orthoester of formula $(RO)_3CR$, R being as defined in claim 1.

5

7. A process according to claim 1, characterized in that it further comprises the step of generating *in situ* the compound of formula (II) starting from the corresponding enal of formula

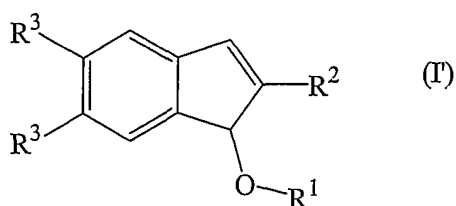


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wherein R^2 and R^3 have the same meaning as indicated in claim 1.

8. A compound of formula

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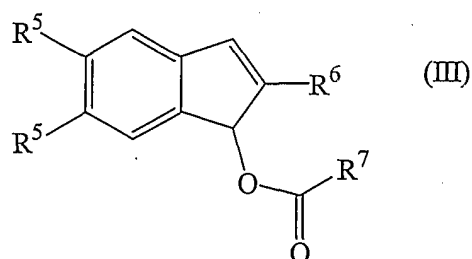


wherein one R^3 is a hydrogen atom and the other R^3 is a C_{1-5} alkyl group, and R^1 and R^2 have the same meaning as in claim 1.

20

9. A compound according to claim 8, characterized in that R^2 is a methyl group and both R^3 are hydrogen atoms or R^2 is a methyl group and one R^3 is a hydrogen atom and the other R^3 is a methyl group.

10. A compound of formula



5 wherein one R⁵ is a hydrogen atom and the other R⁵ is a C₁₋₅ alkyl group and R⁶ or R⁷ represents a methyl or ethyl group;

11. A compound according to claim 10, characterized in that said compound is 2,6-dimethyl-1H-inden-1-yl acetate or 2,6-dimethyl-1H-inden-1-yl propanoate.

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12. Use of a compound according to claim 10 as perfuming ingredient.