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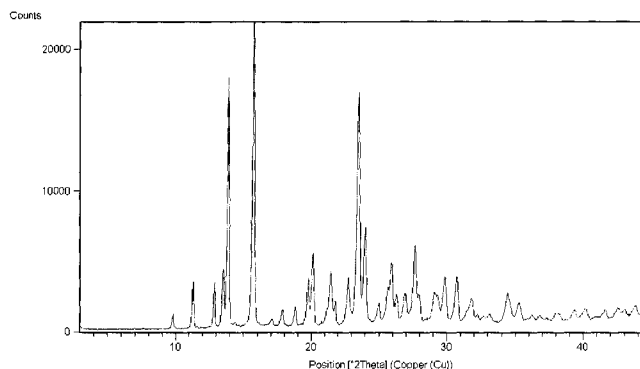
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(54) Title: PROCESS FOR THE PREPARATION OF (S)-(+)-OR (R)-(-)-10 HYDROXY DIHYDRODIBENZ[B,F]AZEPINES BY ENANTIOSELECTIVE REDUCTION OF 10, 11-DIHYDRO-10-OXO-5H-DIBENZ[B,F]AZEPINES AND POLYMORPHS THEREOF

Figure I:

(57) Abstract: The present invention provides a novel process for the preparation of substituted optically pure (S)-(+)- or (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines or derivatives thereof, starting from 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines using boronate esters or their derivatives. The present invention also provides use of thus prepared (S)-(+)- or (R)-(-)- 10-hydroxy-dihydrodibenz[b,f]azepines for the preparation of their ester such as (S)-(-)- 10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy- 10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide. The present invention also provides novel solid state crystalline forms J₁, J₂, J₃, J₄ and amorphous form of eslicarbazepine and the process for the preparation thereof. Also, the present invention provides novel solid state crystalline form and amorphous form of eslicarbazepine acetate and the process for the preparation thereof. The novel solid state forms of eslicarbazepine are useful for the preparation of derivatives of eslicarbazepine such as eslicarbazepine acetate.



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**PROCESS FOR THE PREPARATION OF (S)-(+)- OR
(R)-(-)-10-HYDROXY DIHYDRODIBENZ[B,F]AZEPINES BY
ENANTIOSELECTIVE REDUCTION OF 10,11-DIHYDRO-10-OXO-5H-
DIBENZ[B,F]AZEPINES AND POLYMORPHS THEREOF**

Field of the Invention

The present invention relates to a novel process for the preparation of substituted optically pure (S)-(+)- or (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines or derivatives thereof, starting from 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines using boronate esters or their derivatives. More particularly, the present invention provides a novel process for the preparation of (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide using boronate esters or their derivatives. The present invention also provides use of thus prepared (S)-(+)- or (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines for the preparation of their ester such as (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide.

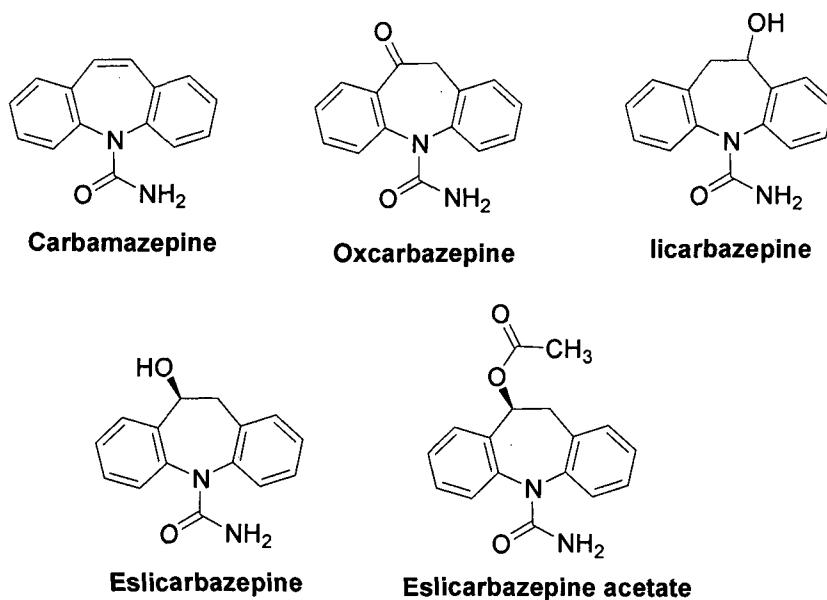
Further, the present invention also provides novel solid state forms of eslicarbazepine and process for the preparation thereof. Further, it relates to the pharmaceutical composition and method of using the formulation to treat conditions in a subject in need thereof. The solid state forms of eslicarbazepine are useful for the treatment of psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder and the like. Also, the novel solid state forms of eslicarbazepine are useful for the preparation of derivatives of eslicarbazepine such as eslicarbazepine acetate.

Background of the Invention

Racemic($\pm$)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide (licarbazepine) is the principal metabolite of the established anti-epileptic drug oxcarbazepine. This compound has been shown to possess valuable pharmacological properties and a particularly high therapeutic index. In the case of oral or rectal administration it has a central depressant action, an anticonvulsive action, which relaxes

the central muscular system and inhibits the fighting reaction of the mouse. These properties determined by selected standard tests [*R. Domenjoz and W. Theobald, Arch. Int. Pharmacodyn.* 120, 450 (1959) and *W. Theobald et al., Arzneimittel Forsch.* 17, 561 (1967)] characterize the compound as being suitable for the treatment of psychosomatic disturbances, epilepsy, trigeminal neuralgia and cerebral spasticity.

Eslicarbazepine acetate is a prodrug of eslicarbazepine (S-licarbazepine), a third-generation drug belonging to the carbamazepine family and the active metabolite of oxcarbazepine. (S)-(+)- 10,11-Dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide (eslicarbazepine) is the key intermediate for the synthesis of antiepileptic drug substance eslicarbazepine acetate.



The synthesis and improved anticonvulsant properties of (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide (BIA 2-093), and (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide (BIA 2-059) have been described by Benes, J. et al., in US 5,753,646 and *J. Med. Chem.*, 42, 2582-2587 (1999). The key step of the synthesis of compounds BIA 2-093 and BIA 2-059 involves the resolution of racemic 10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide into its separate, optically pure enantiomers, (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide and (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide by esterification of racemic 10,11-dihydro-10-hydroxy-

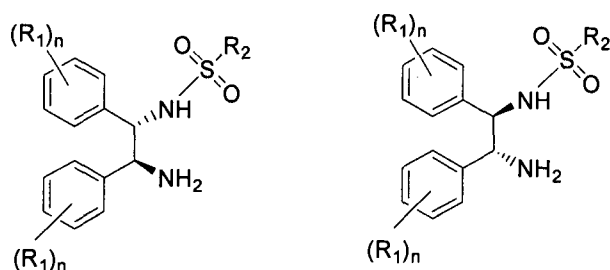
5H-dibenz[b,f]azepine-5- carboxamide with menthoxyacetic acid, separation of the resulting diastereoisomers followed by hydrolysis of the respective optically active menthoxyacetates leads to optically pure enantiomers.

One of the disadvantages of this method is that it can only be utilized for the preparation of only small quantities of each stereoisomer because the necessary optically pure resolving agents, (+) and (-)-menthoxyacetic acid are enormously expensive and are not readily available in sufficient quantities from commercial sources.

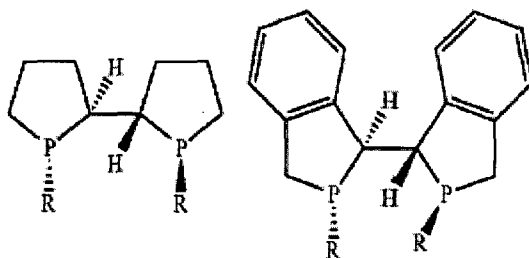
US7119197 discloses a method for the preparation of optically pure (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide and (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide by resolution of racemic ($\pm$)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide using an appropriate tartaric acid anhydride.

US2006142566 discloses a method for the enantioselective preparation of the (S) and (R)-enantiomers of 10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide by asymmetric reduction of oxcarbazepine. The asymmetric reduction is carried out in the presence of a ruthenium catalyst and a hydride source. A suitable catalyst may be formed from $[\text{RuCl}_2(\text{p-cymene})]_2$ and (S,S) or (R,R)-N-(4-toluenesulfonyl)-diphenylethylenediamine. US 2006/0142566 also discloses two crystalline Forms A and B of both the enantiomers of 10,11-dihydro-10 hydroxy-5Hdibenz[b,f]azepine-5-carboxamide, obtainable by the new processes and their usage in the production of pharmaceutical preparations.

US2009203902 discloses a process for preparing (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, by reduction of oxcarbazepine in the presence of a catalyst and a hydride source. The catalyst is prepared from a combination of $[\text{RuX}_2(\text{L})]_2$ wherein X is chlorine, bromine or iodine, and L is an aryl or aryl-aliphatic ligand with a ligand of following formula, wherein the variables are as defined in US2009203902. The disadvantage of this process is again the use of ruthenium complex as a catalyst.



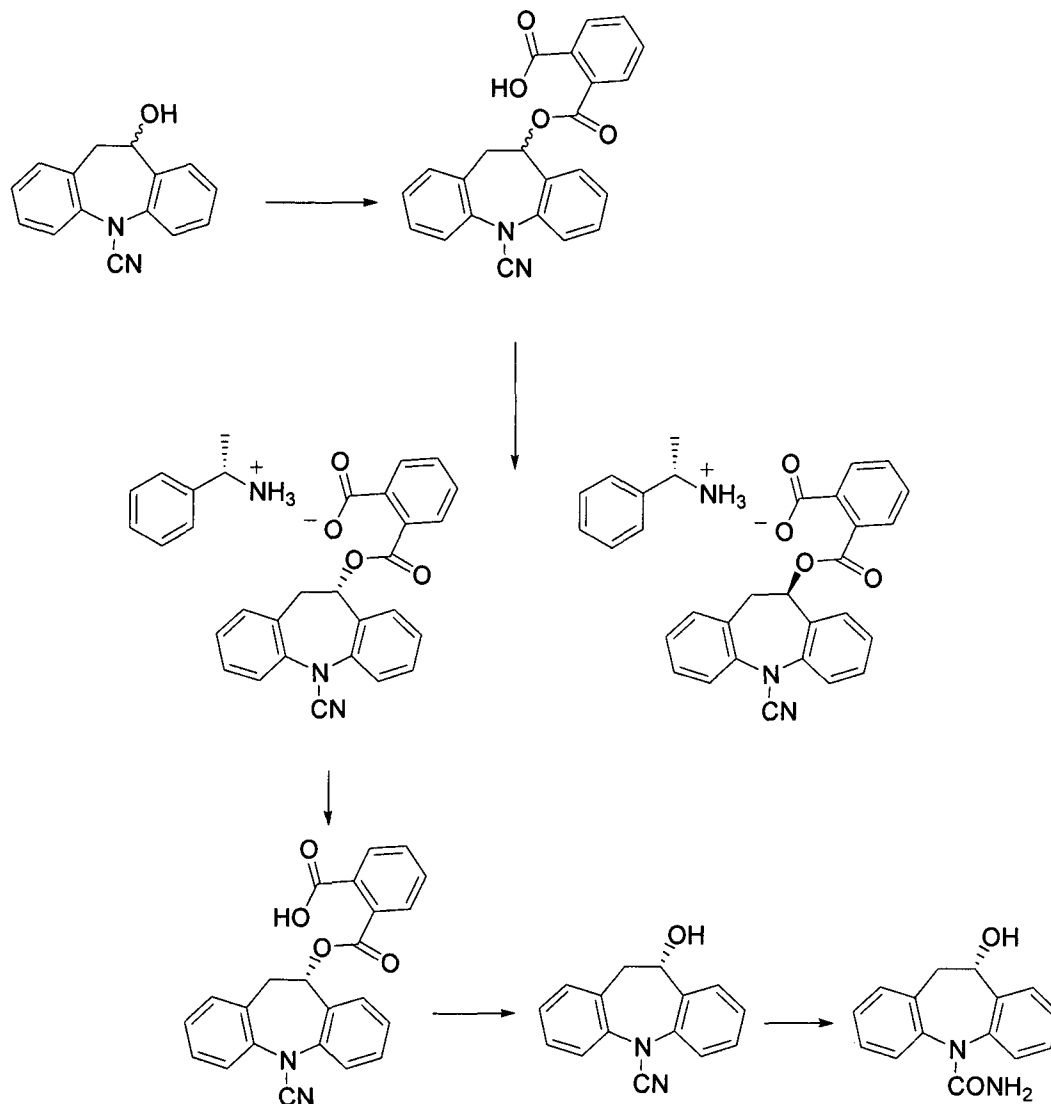
US 2010173893 discloses a process for preparing eslicarbazepine acetate ((S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide) and R-(+)-licarbazepine acetate ((R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide) and their derivatives by asymmetric hydrogenation of the corresponding enol acetate or of the corresponding enol ester derivative using a chiral catalyst and a source of hydrogen. The chiral catalyst is selected from Rh(I) complexes having chiral ligands with the following structures.



The major disadvantages of the above mentioned processes is the residual level of ruthenium/rhodium metal, a most undesirable contaminant in the product, which is high and difficult to remove in a dosage form for the human consumption. Furthermore, these catalysts are expensive and therefore their use can not be regarded as industrially viable.

US 2009105472 discloses a process for preparing (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide starting from racemic 5-cyano-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine by (a) phthaloylation, (b) treating with chiral amine (c) separation of the diastereomeric salts of the phthaloyl derivative with (S)-phenylethylamine, (d) generation of half ester followed by hydrolysis to (S)-(+)-5-cyano-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine and (e) hydrolysis of the nitrile group of the latter to amido group, by treatment with peroxy compounds in alkali medium (Scheme I).

Scheme I



5 Accordingly, for obtaining the optically pure compound, the five steps sequence is carried out, involving more numbers of reagents and solvents, while increasing the time cycle of the entire sequence. Thus, there remains a need for an environment friendly, industrially feasible and economical process for the preparation of (S)-(+)- and (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines.

10 Therefore, a process is required, which avoids expensive menthoxyacetic acid, used in the known process for the preparation of (S)-(+)- and (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines. Moreover, a process is required, which does not involve the

use of any transition metal (e.g. ruthenium or rhodium catalyst), the most undesirable contaminant in the product, for asymmetric catalytic reduction of corresponding keto analogue. Furthermore, the transition metals (e.g. ruthenium or rhodium catalyst) are expensive and therefore their use can not be regarded as industrially viable.

5 *Pharmaceutical Research*, (2008), 25, 530, explains that the ability to deliver the drug to the patient in a safe, efficacious and cost effective way depends largely upon the physicochemical properties of the APIs in the solid state and accordingly one of the challenging tasks in the pharmaceutical industry is to design pharmaceutical materials with specific physiochemical properties. It is known that different solid forms of the same drug
10 may exhibit different properties, including characteristics that have functional implications with respect to their use as drug may have substantial differences in such pharmaceutically important properties as dissolution rates and bioavailability. Likewise, different polymorphs may have different processing properties, such as hygroscopicity, flow ability and the like, which could affect their suitability as active pharmaceuticals for commercial
15 production. Also, it is known in the art that the amorphous forms of APIs generally exhibit the better solubility profile over the corresponding crystalline forms. This is because the lattice energy does not have to be overcome in order to dissolve the solid state structure as in the case for crystalline forms.

20 Thus, there is a need to develop the novel solid state forms of pharmaceutically active compound, having better physicochemical properties; specially, for the enhancement of the solubility. Also, there is a constant need to have the cost effective and industrial friendly process for the preparation of the solid state form.

Brief Description of the Drawings

25 **Figure I** is a characteristic X-ray powder diffraction ("XRPD") pattern of polymorphic Form J₁ of eslicarbazepine.

Figure II is a characteristic infra red (IR) spectrum of polymorphic Form J₁ of eslicarbazepine.

Figure III is a characteristic Differential Scanning Calorimetry (DSC) thermogram of polymorphic Form J₁ of eslicarbazepine.

30 **Figure IV** illustrates the graphic results of a thermogravimetric analysis (TGA) of polymorphic Form J₁ of eslicarbazepine.

Figure V is a characteristic X-ray powder diffraction (“XRPD”) pattern of polymorphic Form J₂ of eslicarbazepine.

Figure VI is a characteristic infra red (IR) spectrum of polymorphic Form J₂ of eslicarbazepine.

5 **Figure VII** is a characteristic Differential Scanning Calorimetry (DSC) thermogram of polymorphic Form J₂ of eslicarbazepine.

Figure VIII illustrates the graphic results of a thermogravimetric analysis (TGA) of polymorphic Form J₂ of eslicarbazepine.

10 **Figure IX** is a characteristic X-ray powder diffraction (“XRPD”) pattern of amorphous eslicarbazepine.

Figure X is a characteristic infra red (IR) spectrum of amorphous eslicarbazepine.

Figure XI is a characteristic Differential Scanning Calorimetry (DSC) thermogram of amorphous eslicarbazepine.

15 **Figure XII** illustrates the graphic results of a thermogravimetric analysis (TGA) of amorphous eslicarbazepine.

Figure XIII is a characteristic X-ray powder diffraction (“XRPD”) pattern of polymorphic Form J₃ of eslicarbazepine.

Figure XIV is a characteristic infra red (IR) spectrum of polymorphic Form J₃ of eslicarbazepine.

20 **Figure XV** is a characteristic Differential Scanning Calorimetry (DSC) thermogram of polymorphic Form J₃ of eslicarbazepine.

Figure XVI illustrates the graphic results of a thermogravimetric analysis (TGA) of polymorphic Form J₃ of eslicarbazepine.

25 **Figure XVII** is a characteristic X-ray powder diffraction (“XRPD”) pattern of polymorphic Form J₄ eslicarbazepine.

Figure XVIII is a characteristic infra red (IR) spectrum of polymorphic Form J₄ eslicarbazepine.

Figure XIX is a characteristic Differential Scanning Calorimetry (DSC) thermogram of polymorphic Form J₄ eslicarbazepine.

30 **Figure XX** illustrates the graphic results of a thermogravimetric analysis (TGA) of polymorphic Form J₄ eslicarbazepine.

Figure XXI is a characteristic X-ray powder diffraction (“XRPD”) pattern of crystalline Form of eslicarbazepine acetate.

Figure XXII is a characteristic infra red (IR) spectrum of crystalline Form of eslicarbazepine acetate.

- 5 **Figure XXIII** is a characteristic Differential Scanning Calorimetry (DSC) thermogram of crystalline Form of eslicarbazepine acetate.

Figure XXIV illustrates the graphic results of a thermogravimetric analysis (TGA) of crystalline Form of eslicarbazepine acetate.

- 10 **Figure XXV** is a characteristic X-ray powder diffraction (“XRPD”) pattern of amorphous Form of eslicarbazepine acetate.

Figure XXVI is a characteristic infra red (IR) spectrum of amorphous Form of eslicarbazepine acetate.

Figure XXVII is a characteristic Differential Scanning Calorimetry (DSC) thermogram of amorphous Form of eslicarbazepine acetate.

- 15 **Figure XXVIII** illustrates the graphic results of a thermogravimetric analysis (TGA) of amorphous Form of eslicarbazepine acetate.

Description of the invention

The process of the present invention affords the important advantage of making use of boronate esters, for enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines (II), which are less expensive and does not lead to undesirable
20 contaminant(s) in the product and does not require any special equipment.

Accordingly, one embodiment of the invention is to provide a method for the preparation of substituted/unsubstituted optically pure (S)-(+)- or (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines or derivatives thereof, starting from 10,11-dihydro-10-oxo-
25 5H-dibenz[b,f]azepines or derivatives thereof, wherein the method is readily amenable to industrial batch-size production.

Moreover, the process of the present invention has been devised in such a manner that it can provide high yields of optically pure (S)-(+)- or (R)-(-)-10-hydroxy-dihydrodibenz[b,f]azepines or derivatives thereof without generation of the undesired

isomer as in case of diastereomeric resolution processes, which can provide maximum yield of upto 50% with respect to desired isomer.

In an embodiment, the invention provides a process for preparing (S)-(+)-10,11 -dihydro- 10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or derivatives thereof, by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines or derivatives thereof in presence of boronate esters.

The process for enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines or derivatives thereof in presence of boronate esters, wherein boronate ester is selected from dihydroxy compound derived esters of boronic acid or their derivatives.

In an another embodiment, the invention provides a process for preparing (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines, by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines or derivatives thereof in presence of borohydride compound and tartaric acid derived ester of boronic acid or there derivatives.

In an another embodiment, the invention provides a process for preparing (S)-(+)-10,11 -dihydro- 10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide or derivatives thereof in presence of borohydride compound and tartaric acid derived ester of boronic acid or derivatives thereof.

In an another embodiment, the invention provides a process for preparing (S)-(+)-10,11 -dihydro- 10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide or derivatives thereof in presence of borohydride compound and tartaric acid derived ester of phenyl boronic acid.

In an another embodiment, the invention provides a process for preparing (S)-(+)-10,11 -dihydro- 10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide or derivatives thereof in
5 presence of sodium borohydride and tartaric acid derived ester of phenyl boronic acid.

In an another embodiment, the invention provides a process for preparing (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide from (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]
10 azepine, which are obtained by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine or derivatives thereof in presence of boronate esters.

In an another embodiment, the invention provides a process for preparing (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide from (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]
15 azepine, which are obtained by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine or derivatives thereof in presence of borohydride compound and tartaric acid derived ester of phenyl boronic acid.

In an another embodiment, the invention provides a process for preparing (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide from (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, which are obtained by enantioselective reduction of
20 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide or derivatives thereof in
25 presence of boronate esters.

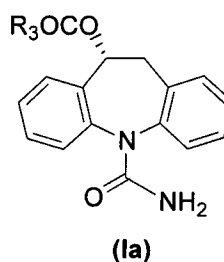
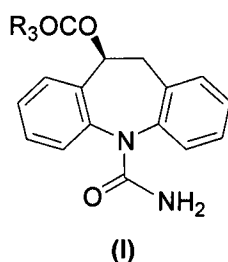
In an another embodiment, the invention provides a process for preparing (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide from (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide or (R)-(-)-10,11-dihydro-10-hydroxy-5H-

dibenz[b,f]azepine-5-carboxamide, which are obtained by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide or derivatives thereof in presence of borohydride compound and tartaric acid derived ester of phenyl boronic acid or derivatives thereof.

- 5 In an another embodiment, the invention provides a process for preparing (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide from (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, which are obtained by enantioselective reduction of
 10 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide or derivatives thereof in presence of sodium borohydride and tartaric acid derived ester of phenyl boronic acid.

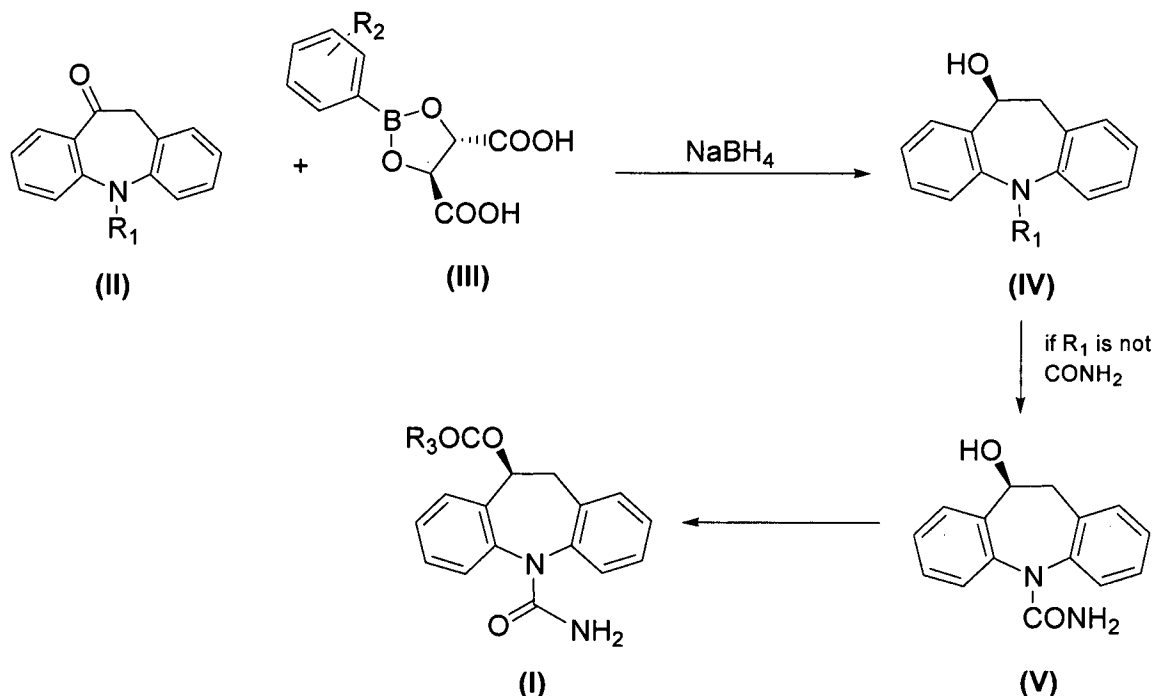
In yet another embodiment, the invention provides a process for the preparation of optically pure (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, comprising:

- 15 a) reacting 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide with boronate esters or their derivatives in presence of borohydride compounds to obtain (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide;
 b) optionally, if R₁ is not -CONH₂ group then converting R₁ to -CONH₂ to obtain the
 20 optically pure (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide;
 c) optionally, converting compound obtained after steps 'a' or 'b' into their prodrug esters of formula (I) or (Ia);



The invention, specifically with respect to (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide and the other reagents, though not limited, can be read in concurrence with the reaction scheme as shown in Scheme II.

Scheme II



Wherein,

R_1 is CN, $-\text{CONH}_2$, $-\text{CONHP}$ (P is protecting group), $-\text{COX}_1$ (X_1 is halogen) or $-\text{COOR}_4$

R_2 may be but not restricted to hydrogen, alkyl, aryl, halogen, alkoxy, aryloxy, nitro, cyano, acyl, acyloxy and the like. The said substitution may further be substituted.

R_3 is alkyl, halogenalkyl, aralkyl, cycloalkyl, cycloalkylalkyl, alkoxy, aryl or pyridyl; the term alkyl means carbon chain, straight or branched, containing from 1 to 18 carbon atoms; the term halogen represents fluorine, chlorine, bromine or iodine; the term cycloalkyl represents an alicyclic saturated group with 3 to 6 carbon atoms; and the term aryl represents unsubstituted phenyl group or phenyl substituted by alkoxy, halogen, nitro and the like.

R₄ is acid protecting group such as alkyl, substituted or unsubstituted aryl or aralkyl group;

The substituted or unsubstituted boronate esters used in step 'a' can be obtained by reacting boronic acid derivatives, such as phenyl boronic acid or derivatives thereof, with
5 a dihydroxy compound such as tartaric acid or derivatives thereof.

Borohydride compounds used in step 'a' can be selected from but not restricted to alkali metal borohydrides such as sodium borohydride, lithium borohydride, potassium borohydride, sodium cyanoborohydride, NaBH(OAc)₃ and the like; alkaline earth metal borohydrides such as magnesium borohydride, calcium borohydride and the like;
10 transition metal borohydrides such as zinc borohydride and the like; tetra alkyl ammonium borohydrides such as tetra butyl ammonium borohydride and the like; lithium aluminum hydride, and the like; BH₃-ligand complex such as BH₃-THF complex and the like.

The reaction in the step 'a' for the preparation of (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-
15 5H-dibenz[b,f]azepines is carried out by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines in presence of solvent selected from the group comprising of ethers such as tetrahydrofuran, diethyl ether, dioxane, diglyme, tetraglyme and the like; amides such as N-methylpyrrolidine and the like; nitriles such as acetonitrile and the like; sulfoxides, hydrocarbons (aliphatic or aromatic) such as benzene, toluene and the like;
20 chlorinated hydrocarbons (aliphatic or aromatic) such as dichloromethane and the like or mixture thereof.

In another embodiment there is provided a pharmaceutical composition that includes therapeutically effective amount of (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines prepared
25 by the process of present invention and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another embodiment there is provided use of a pharmaceutical composition that includes a therapeutically effective amount (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines prepared

by the process of present invention and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment of psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In another embodiment there is provided pharmaceutical composition that includes therapeutically effective amount of (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide prepared by the process of present invention and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another embodiment there is provided use of pharmaceutical composition that includes therapeutically effective amount (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide prepared by the process of present invention and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment of psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In yet another embodiment the present invention provides novel solid state forms of eslicarbazepine i.e. crystalline and amorphous forms of eslicarbazepine.

In yet another embodiment the present invention provides a process for the preparation of the novel solid state forms i.e. crystalline and amorphous forms of eslicarbazepine. The said process comprises of dissolving eslicarbazepine in one or more solvents; and recovering the eslicarbazepine in the various solid state forms by the removal of solvent.

A "solvent" as defined herein is selected from the group comprising of alcohols, nitriles, ketones, esters, ethers, amides, dialkylsulfoxide, water or the mixtures thereof. Alcohols are selected from the group comprising of methanol, ethanol, n-propanol, isopropanol, n-butanol and the like. The nitriles are selected from the group comprising of acetonitrile, propionitrile, butyronitrile, valeronitrile and the like. Ketones are selected from the group comprising of acetone, methyl ethyl ketone, methyl isobutyl ketone etc. Esters are selected from the group comprising of ethyl acetate, propyl acetate and the like.

Chlorinated solvents are selected from the group comprising of dichloromethane, chloroform, dichloroethane, chlorobenzene and the like. Ethers can be selected from the group comprising of diethyl ether, diisopropyl ether, tetrahydrofuran, dioxane and the like. Amides can be selected from the group comprising of dimethylformamide, dimethylacetamide, N-methyl formamide, N-methyl pyrrolidine and the like. Dialkyl sulfoxide can be selected from the group comprising of dimethyl sulfoxide, sulfolane diethyl sulfoxide, dibutyl sulfoxide and the like.

A "water soluble organic solvent" as defined herein includes but not only limited to the solvents selected from the group comprising of alcohols such as methanol, ethanol and isopropanol and the like; ketones such as acetone methyl ethyl ketone and the like, lower alkyl glycol ethers such as methyl glycol and the like; dipolar aprotic solvents such as N, N-dimethyl formamide (DMF), N, N-dimethylacetamide (DMA), N-methyl pyrrolidine and dimethyl sulfoxide (DMSO), sulfolane and cyclic ethers such as tetrahydrofuran, dioxane and the like or mixture(s) thereof.

The invention provides the novel stable crystalline and amorphous forms of eslicarbazepine.

In yet another embodiment, the invention provides novel crystalline polymorphic form J₁ of eslicarbazepine.

The novel crystalline Form J₁ of eslicarbazepine is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure I.

The novel crystalline Form J₁ of eslicarbazepine is characterized by its infra red (IR) spectrum substantially as depicted in Figure II.

The novel crystalline Form J₁ of eslicarbazepine is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure III.

The novel crystalline Form J₁ of eslicarbazepine is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure IV.

In an another embodiment the invention provides a process for the preparation of Form J₁ of eslicarbazepine which can be obtained by removing organic solvent(s) from a solution of water and organic solvent(s) in presence of excess of water.

In yet another embodiment, the invention provides the use of Form J₁ of eslicarbazepine to prepare the derivatives of eslicarbazepine, such as eslicarbazepine acetate.

In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₁ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another aspect there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₁ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In another embodiment, the invention provides novel crystalline polymorphic form J₂ of eslicarbazepine.

The novel crystalline Form J₂ of eslicarbazepine is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure V.

The novel crystalline Form J₂ of eslicarbazepine is characterized by its IR spectrum substantially as depicted in Figure VI.

The novel crystalline Form J₂ of eslicarbazepine is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure VII.

The novel crystalline Form J₂ of eslicarbazepine is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure VIII.

In an another embodiment, the invention provides a process for the preparation of Form J₂ of eslicarbazepine, which can be obtained by removing organic solvent(s) from a solution of eslicarbazepine in organic solvent(s) followed by treatment with water or mixture thereof with organic solvent(s).

In yet another embodiment, the invention provides the use of Form J₂ of eslicarbazepine to prepare the derivatives of eslicarbazepine, such as eslicarbazepine acetate.

In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₂ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another aspect, there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₂ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In yet another embodiment, the invention provides novel crystalline polymorphic Form J₃ of eslicarbazepine.

The novel crystalline Form J₃ of eslicarbazepine is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure IX.

The novel crystalline Form J₃ of eslicarbazepine is characterized by its infra red (IR) spectrum substantially as depicted in Figure X.

The novel crystalline Form J₃ of eslicarbazepine is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XI.

The novel crystalline Form J₃ of eslicarbazepine is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure XII.

In another embodiment, the invention provides a process for the preparation of Form J₃ of eslicarbazepine, which can be obtained from a solution of eslicarbazepine in a mixture of water soluble organic solvent and water.

In yet another embodiment, the invention provides the use of Form J₃ of eslicarbazepine to prepare the derivatives of eslicarbazepine, such as eslicarbazepine acetate.

In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₃ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another aspect, there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₃ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents to treat

conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In yet another embodiment, the invention provides novel crystalline polymorphic
5 form J₄ of eslicarbazepine.

The novel crystalline Form J₄ of eslicarbazepine is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure XIII.

The novel crystalline Form J₄ of eslicarbazepine is characterized by its IR
10 spectrum substantially as depicted in Figure XIV.

The novel crystalline Form J₄ of eslicarbazepine is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XV.

The novel crystalline Form J₄ of eslicarbazepine is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure XVI.

15 In another embodiment, the invention provides a process for the preparation of Form J₄ of eslicarbazepine which can be obtained by removing water miscible organic solvent(s) from a solution of water and water miscible organic solvent(s) in presence of less amount of water.

In yet another embodiment, the invention provides the use of Form J₄ of
20 eslicarbazepine to prepare the derivatives of eslicarbazepine, such as eslicarbazepine acetate.

In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₄ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents.

25 In yet another aspect, there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount of novel crystalline Form J₄ of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or
30 nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In another embodiment, the invention provides amorphous Form of eslicarbazepine.

The amorphous Form of eslicarbazepine is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure XVII.

5 The amorphous Form of eslicarbazepine is characterized by its IR spectrum substantially as depicted in Figure XVIII.

The amorphous Form of eslicarbazepine is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XIX.

10 The amorphous Form of eslicarbazepine is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure XX.

An embodiment of the present invention provides a process for the preparation of the amorphous form of eslicarbazepine. The process comprises of dissolving eslicarbazepine in one or more solvents; and recovering the eslicarbazepine in the amorphous form by the removal of solvent.

15 The method for removal the solvent can be selected to obtain the amorphous form of eslicarbazepine using the processes comprising of spray drying, distillation under vacuum, roller drying, freeze drying i.e. lyophilization, thin film drying and the like.

In another embodiment, the eslicarbazepine is milled by grinding action between two surfaces till the time amorphous eslicarbazepine is obtained. Such milling can be carried out by using a traditional technique of compounding using a pestle and mortar or by milling machines that essentially work on the same principle. Examples of such milling machines can be selected from the group comprising of ball mills, roller mills, jet mills, gyratory mills, and the like.

20 In other embodiment, the invention provides a method for preparation of physical forms of eslicarbazepine by quenching a melt of eslicarbazepine.

In yet another embodiment, the invention provides the use of amorphous form of eslicarbazepine to prepare the derivatives of eslicarbazepine, such as eslicarbazepine acetate.

30 In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of amorphous Form of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another aspect, there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount amorphous Form of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In another embodiment, the invention provides a crystalline polymorphic Form of eslicarbazepine acetate.

The crystalline Form of eslicarbazepine acetate is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure XXI.

The crystalline Form of eslicarbazepine acetate is characterized by its IR spectrum substantially as depicted in Figure XXII.

The crystalline Form of eslicarbazepine acetate is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XXIII.

The crystalline Form of eslicarbazepine acetate is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure XXIV.

In an another embodiment, the invention provides a process for the preparation of crystalline Form of eslicarbazepine acetate, which can be obtained by crystallization using a solvent or mixture of solvents or by removal of solvent(s) from a solution of eslicarbazepine acetate or by precipitation of a solution of eslicarbazepine acetate in organic solvent(s) using anti-solvent.

In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of crystalline Form of eslicarbazepine acetate and one or more pharmaceutically acceptable carriers, excipients or diluents.

In yet another aspect, there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount crystalline Form of eslicarbazepine acetate and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

In another embodiment, the invention provides amorphous Form of eslicarbazepine acetate.

The amorphous Form of eslicarbazepine acetate is characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure XXV.

The amorphous Form of eslicarbazepine acetate is characterized by its IR spectrum substantially as depicted in Figure XXVI.

The amorphous Form of eslicarbazepine acetate is characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XXVII.

The amorphous Form of eslicarbazepine acetate is characterized by graphic results of thermogravimetric analysis (TGA) as depicted in Figure XXVIII.

An embodiment of the present invention provides a process for the preparation of the amorphous form of eslicarbazepine acetate. The process comprises of dissolving eslicarbazepine acetate in one or more solvents; and recovering the eslicarbazepine acetate in the amorphous form by the removal of solvent.

The method for removal of the solvent to obtain the amorphous form of eslicarbazepine acetate can be selected from the processes comprising of spray drying, distillation under vacuum, roller drying, freeze drying i.e. lyophilization, thin film drying and the like.

In another embodiment, the eslicarbazepine acetate is milled by grinding action between two surfaces till the time amorphous eslicarbazepine acetate is obtained. Such milling can be carried out by using a traditional technique of compounding using a pestle and mortar or by milling machines that essentially work on the same principle. Examples of such milling machines can be selected from the group comprising of ball mills, roller mills, jet mills, gyratory mills, and the like.

In other embodiment, the invention provides a method for preparation of physical forms of eslicarbazepine acetate by quenching a melt of eslicarbazepine acetate.

In yet another embodiment, the invention provides the use of amorphous form of eslicarbazepine acetate to prepare other polymorphic forms of eslicarbazepine acetate.

In another aspect, there is provided a pharmaceutical composition that includes a therapeutically effective amount of amorphous form of eslicarbazepine acetate as depicted above and one or more pharmaceutically acceptable carriers, excipients or diluents.

5 In yet another aspect there is provided a use of a pharmaceutical composition that includes a therapeutically effective amount amorphous form of eslicarbazepine acetate as depicted above and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease,
10 bipolar disorder etc.

In yet another aspect of the invention, the eslicarbazepine has particles size having $d_{0.9}$ less than 200 μm , $d_{0.5}$ less than 80 μm and $d_{0.1}$ less than 35 μm .

In yet another aspect of the invention, the eslicarbazepine acetate has particles size having $d_{0.9}$ less than 200 μm , $d_{0.5}$ less than 70 μm and $d_{0.1}$ less than 20 μm .

15 The process for the preparation of (S)-(+)- and (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide derivatives described in the present invention is demonstrated in the examples illustrated below. These examples are provided as illustration only and therefore should not be constructed as limitation of the scope of the invention.

20 **Examples**

Example 1:

Preparation of Eslicarbazepine

A solution of phenyl boronic acid (48.5 gm), D-(-)-tartaric acid (59.4 gm), calcium hydride (33.2 gm) in acetonitrile (750 mL) was heated to about 80-85°C for about 1 hr.
25 The reaction mass was cooled to about 25-30°C ('Solution X'). A solution of oxcarbazepine (50 gm) in acetonitrile (250 mL) was prepared separately. 'Solution X' obtained above was added to the solution of oxcarbazepine followed by stirring the reaction mass for about 2 hrs. To the resulting solution sodium borohydride (59.4 gm) was added at about 30-35°C. The reaction mass was stirred at the same temperature for about
30 8-10 hrs followed by distillation of solvent. To the resulting residue water (1000 mL) was

added. The pH of the resulting solution was adjusted to about 12-13 by adding NaOH solution. The reaction mass was heated to about 55-60°C followed by stirring at the same temperature for about 1 hr. consequently, cooled the reaction mass to about 20-25°C. The reaction mass was stirred at the same temperature for about 4 hrs. The reaction mass was again cooled to about 10-15°C and stirred for about 3 hrs. The resulting solid (35 gm) was filtered, washed and dried to obtain the title compound (Yield: 70 %; HPLC purity: 99.5 %; Chiral purity: 96.4%; $d_{0.9}$ 114.3 μm , $d_{0.5}$ 53.1 μm , $d_{0.1}$ 22 μm).

Example 2:

Preparation of Eslicarbazepine

A solution of phenyl boronic acid (19.4 gm), D-(-)-tartaric acid (23.8 gm), calcium hydride (13.3 gm) in acetonitrile (300 mL) was heated to about 80-85°C for about 1 hr. The reaction mass was cooled to 25-30°C ('Solution X'). A solution of oxcarbazepine (20 gm) in acetonitrile (100 mL) was prepared separately. 'Solution X' obtained above was added to the solution of oxcarbazepine followed by stirring the reaction mass for about 2 hrs. To the resulting solution sodium borohydride (4.5 gm) was added at about 30-35°C. The reaction mass was stirred at the same temperature for about 8 hrs. The pH of the resulting solution was adjusted to 1-2 by adding HCl (3N, 200mL) followed by stirring for about 30 minutes. To the resulting solution, NaOH (20% w/v) solution was added to adjust the pH at about 12-13. Dichloromethane was added to the resulting solution followed by stirring. The organic layer was separated and distilled to obtain the title compound (Yield: 91%; HPLC purity: 98.6%; Chiral purity: 92.5%).

Example 3:

Preparation of eslicarbazepine acetate

A solution of eslicarbazepine (18 gm), triethylamine (8.5 gm), dimethylaminopyridine (0.1 gm), acetic anhydride (8.7 gm) and dichloromethane (90 mL) was stirred at about 20-25°C for about 4 hrs. To the resulting solution water was added and resulting solution was stirred for about 15 minutes. Organic layer was separated and washed with 1 N HCl solution followed by washing with water. The solvent was distilled out completely. Ethyl acetate was added to the resulting residue followed by stirring at about 25-30°C for about 3 hrs. The resulting solid was filtered, washed and dried to obtain the title compound (Yield: 80%; HPLC purity: 99.8%; Chiral purity: 99.3%; $d_{0.9}$ 50.7 μm , $d_{0.5}$ 17.3 μm , $d_{0.1}$ 6.0 μm).

Example 4:**Preparation of eslicarbazepine acetate**

To a solution of eslicarbazepine (30 gm), triethylamine (19.7 gm),
5 dimethylaminopyridine (0.15 gm), and dichloromethane (150 mL), acetic anhydride (14.5
mL in 14.5mL dichloromethane) was added and solution was stirred at about 20-25°C for
about 3 hrs. The resulting solution was cooled to about 10-15°C. To the resulting solution
water (90 mL) was added followed by addition of HCl till pH of the resulting solution was
1-2. Organic layer was separated and washed with water. Water was added to organic
10 layer followed by cooling to about 10-15°C. The pH of the resulting solution was adjusted
to 9-10 by adding NaOH (10% w/v) solution. Organic layer was separated and solvent was
distilled out completely to obtain the title compound.

Example 5:**Purification of eslicarbazepine acetate**

15 To a solution of eslicarbazepine acetate (22 gm) isopropanol (110 mL) was added
and the reaction mass was heated to about 80-85°C followed by stirring for about 1 hr. The
reaction mass was cooled to about 30°C followed by stirring at the same temperature for
about 1 hr. The resulting solid was filtered, washed with isopropanol and dried to obtain
the title compound. (The above purification step may be repeated one or more times to
20 obtain the desired purity.) Yield: 79%; HPLC purity: 99.9%; Chiral purity: 99.9%; $d_{0.9}$
90.3 μm , $d_{0.5}$ 44.2 μm , $d_{0.1}$ 10.7 μm).

Example 6:**Preparation of N-Boc-phenylalanine**

L-phenylalanine (50 gm) in water (50 mL) is stirred for about 30 minutes and
25 reaction mass was cooled to 10-15°C. To the resulting solution aq. NaOH is added
followed by addition of Boc anhydride (39.5 mL). Stirred the reaction mass at about 25°C
for about 4-5 h. Cyclohexane and water was added to the resulting solution followed by
layer separation. The aq. layer was cooled and aq. KHSO₄ solution was charged to it with
subsequent addition of ethyl acetate (250 mL). Ethyl acetate layer was separated and
30 washed with water. Ethyl acetate was distilled off completely. Cyclohexane and ethyl
acetate was added to the residue. Reaction mass was cooled to 5-10°C and stirred for 4-5

h. The reaction mass filtered, washed with chilled cyclohexane and dried under vacuum to obtain the title compound.

Example 7:

Preparation of 2-isobutoxycarbonylamino-3-phenyl-propionic acid

5 L-phenylalanine (50 gm) in water (50 mL) was stirred for about 30 minutes and reaction mass was cooled to 10-15°C. To the resulting solution, aq. NaOH was added followed by addition of isobutylchloroformate (45.5 gm). The reaction mass was stirred at about 25°C for about 3-4 h and pH was adjusted to 2-3 by addition of conc. HCl at 10-15°C. Reaction mass was stirred at 10-15°C for 1 h, filtered, washed with water and dried
10 to obtain the title compound.

Example 8:

Preparation of (1-chlorocarbonyl-2-phenylethan-1-yl)-carbamic acid isobutyl ester

A solution of 2-isobutoxycarbonylamino-3-phenyl-propionic acid (5 gm), dichloromethane (25 mL) and dimethylformamide (0.5 mL) was cooled to 0-5°C. To the
15 resulting solution, thionyl chloride (1.5 mL) was added at same temperature. The solvent was distilled out completely to obtain the title compound.

Example 9:

Preparation of isobutyloxycarbonyl protected phenylalanine ester of licarbazapine

A solution of (1-chlorocarbonyl-2-phenyl-ethyl)-carbamic acid isobutyl ester (5
20 gm), obtained solution in dichloromethane was added to a solution of licarbazepine (4 gm), pyridine (2.2 mL), dimethylaminopyridine (0.05 gm) and dichloromethane (60 mL) at 5-10°C. Reaction mass was stirred at room temperature for 4 h and washed with water. The solvent was distilled to obtain the title compound.

Example 10:

Preparation of isobutyloxycarbonyl protected phenylalanine ester of eslicarbazapine

A solution of isobutyl carbamate protected phenylalanine ester of licarbazapine (5
25 gm) in methanol (1.5 mL) and ethyl acetate (50 mL) was heated to 70-75°C. The reaction mass was cooled to about 30°C and stirred for about 1 h at the same temperature. Reaction mass was filtered, washed with ethyl acetate and dried to obtain the title compound.

Example 11:

Preparation of N-Boc-protected phenylalanine ester of licarbazapine

A solution of N-Boc phenylalanine (15 gm) and triethyl amine (11.9 gm) in dichloromethane (60 mL) was cooled to 0-5°C. To the resulting solution pivaloyl chloride (6.5 mL) was added at same temperature. The reaction mass was stirred for 1 h at 20-25°C and then filtered. Thus obtained filtrate was added to a solution of licarbazepine, pyridine (5.5 g), dimethylaminopyridine (1 gm) in dichloromethane (60 mL) at 20-25°C. Reaction mass was stirred for 3-4 h and washed with 2% sodium bicarbonate solution (50 mL). The solvent was distilled to obtain the title compound.

Example 12:

Preparation of N-Boc-protected phenylalanine ester of licarbazepine

A solution of licarbazepine (4 g), dimethylaminopyridine (0.05 gm), N-Boc. phenylalanine (2.2 mL) and dichloromethane (60 mL) was cooled to 5-10°C. N,N-dicyclohexylcarbodiimide (DCC) was added to the above solution followed by stirring at 5-10°C for about 6 h. The temperature was raised to 25-30°C and reaction mass was filtered and washed with chilled dichloromethane (12 mL). The filtrate was distilled to obtain the title compound.

Example 13a:

Preparation of N-Boc-protected phenylalanine ester of eslicarbazepine

A solution of N-Boc protected phenylalanine ester of licarbazepine (33 gm) in dichloromethane (200 mL) was heated to 35-40°C. The reaction mass was cooled to 0°C and stirred for about 1 h at the same temperature. Reaction mass was filtered, washed with chilled dichloromethane and dried to obtain the title compound.

Example 13b:

Preparation of N-Boc-protected phenylalanine ester of eslicarbazepine

A solution of N-Boc protected phenylalanine ester of licarbazepine (5 gm) in methanol (100 mL) and water (10 mL) was heated to 65-70°C. The reaction mass was cooled to 30°C. Stirred the reaction mass at 65-70°C for 1 h. Reaction mass was filtered, washed with methanol and dried to obtain the title compound.

Example 14:

Preparation of eslicarbazepine (Form J₁) from N-isobutyl carbamate ester

To a solution of isobutyl carbamate protected phenylalanine ester of eslicarbazepine (15 gm) in methanol (45 mL), was added aq. solution of NaOH (1.8 gm NaOH in 120 mL) 25-30°C. The mixture was stirred at 25-30°C for 3 hrs. To the resulting

mixture dichloromethane (45 mL) was added and stirred for 1 hr. The reaction mass was distilled out under vacuum at 50-55°C. Then 7 mL methanol and 80 mL water was added to the residue followed by heating at 75-80°C for 30 min. The reaction mass was cooled to 25-30°C and stirred for 2 hrs. Solid was filtered and dried under vacuum at 50-55°C to obtain the title compound (m. p. 188.5-190.5° C).

Example 15:

Preparation of eslicarbazepine (Form J₂) from N-Isobutyl carbamate ester

To a solution of isobutyl carbamate protected phenylalanine ester of eslicarbazepine (27 gm) in dichloromethane (216 mL), aq. solution of NaOH (3.25 gm NaOH in 162 mL water) was added at 25-30°C. Stirred the reaction mass at 25-30°C for 2 hrs followed by stirring at 35-40°C for 2 hrs. Added 270 mL methanol and stirred at 25-30°C for 2 hrs. Dichloromethane (135 mL) was added and stirred. Organic layer was collected. Aq. layer was concentrated under vacuum at 50-55°C and then cooled to room temperature. Extracted the aq. layer with dichloromethane (2 x 200 mL) and combined organic layer was distilled under vacuum at 50-55°C. Then 27 ml water was added to the residue and heated at 65-70°C. The reaction mixture was cooled and stirred at 25-30°C for 2 hrs. Solid was filtered, washed with water and dried under vacuum at 50-55°C to obtain the title compound (m. p. 189.3-190.1° C).

Example 16:

Preparation of polymorphic Form J₃ of eslicarbazepine

A solution of eslicarbazepine (500 mg) in methanol (7 mL) was heated at 40-45°C for 15 min. The reaction mass was cooled at 25-30°C. The solution was filtered. The solution was concentrated and followed by addition of 20 mL of water. Cooled the clear solution to 5-10°C and stirred for 30 min. Filtered the solid, washed with water and dried to obtain title compound (m. p. 186.1-190.1° C).

Example 17:

Preparation of polymorphic Form J₃ of eslicarbazepine

A solution of eslicarbazepine (500 mg) in methanol (10 mL) was stirred at 25-30°C for 15 min. Added 20 mL water to the solution. Distilled out solvent under vacuum at 50-55°C slowly, till the precipitation starts. Stirred the suspended solution at 25-30°C for 30 min. Solution is filtered, washed and dried to obtain title compound (m. p. 186.1-190.1° C).

Example 18:**Preparation of Form J₄ of eslicarbazepine**

To a solution of N-Boc protected phenylalanine ester of eslicarbazepine (45 gm) in methanol (270 mL), aq. NaOH (3N, 126 mL) was added at 20-25°C. Stirred the reaction mass at 25-30°C for 1 h and distilled out solvent completely under vacuum at 50-55°C. Water was added to the residue followed by heating at 65-70°C for 1 h, then cooled to 25-30°C, and stirred for 3 hrs at 25-30°C further cooled to 5-10°C and stirred for 1 hr at 5-10°C. Reaction mass was filtered, washed and dried to obtain the title compound (m. p. 183.8-185.8° C).

Example 19:**Preparation of amorphous eslicarbazepine**

A solution of eslicarbazepine (500 mg) in methanol (10 mL) was heated at 40-45°C for 15 min. Cooled the solution at 30°C. The solution was filtered and the solvent was distilled out. The solid residue was dried to obtain the title compound (m. p. 70.4-100.9° C).

Example 20:**Preparation of amorphous eslicarbazepine**

A suspension of eslicarbazepine (500 mg) in dichloromethane (18 mL) was heated at 35-40°C for 1 hr. Added methanol (5 mL) to make solution clear and continue heating for another 15 min. Cooled the solution at 25-30°C. The solvent was distilled out under vacuum at 40°C till complete dryness. Solid residue was dried under vacuum at 50°C for 2 hrs.

Example 21:**Preparation of eslicarbazepine acetate**

A solution of eslicarbazepine (15.0 gm), pyridine (8 mL), dimethylaminopyridine (0.17 gm) in dichloromethane (150 mL) was cooled to 5-10°C. Added acetyl chloride (7.6 mL) at about 5-10°C followed by stirring at 35-40°C for about 5-6 h. Washed the reaction mass with 0.5N HCl solution (45 mL) and followed by washing the organic layer with water (100 mL). Distilled out the solvent completely under vacuum to obtain crude eslicarbazepine acetate. The residue was dissolved in a mixture (60 mL) of dichloromethane and ethyl acetate (1:1) at 35-40°C then cooled to 25-30°C. Reaction mass

was filtered, washed with ethyl acetate and dried to obtain the title compound (m. p. 186.0-187.2° C).

Example 22:

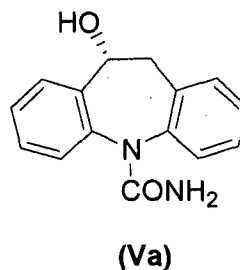
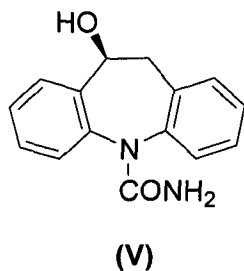
Preparation of amorphous eslicarbazepine acetate

- 5 Eslicarbazepine Acetate (1 g) was dissolved in methylene dichloride (30 mL). The resulting solution was distilled in preheated water bath to obtain amorphous eslicarbazepine acetate (m. p. 184.6-185.4° C).

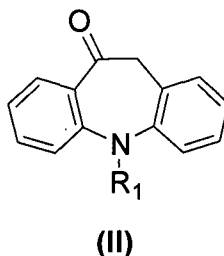
Claims:

1. A process for preparing (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or derivatives thereof, by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines or derivatives thereof in presence of boronate esters.
2. The process for enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines or derivatives thereof in presence of boronate esters according to claim 1, wherein boronate ester is selected from dihydroxy compound derived esters of boronic acid or their derivatives.
3. The process according to claim 2, wherein dihydroxy compound is tartaric acid or derivatives thereof.
4. The process according to claim 2, wherein enantioselective reduction with boronate ester is carried out in presence of a borohydride compound.
5. The process according to claim 4, wherein borohydride compound is selected from the group comprising of alkali metal borohydrides, alkaline earth metal borohydrides, transition metal borohydrides, tetra alkyl ammonium borohydrides, lithium aluminum hydrides and BH_3 -ligand complex.
6. The process according to claim 2, wherein boronic acid is substituted or unsubstituted phenyl boronic acid.
7. The process according to claim 5, wherein alkali metal borohydride is selected from the group comprising of sodium borohydride, lithium borohydride, potassium borohydride, sodium cyanoborohydride and $\text{NaBH}(\text{OAc})_3$.
8. The process according to claim 5, wherein alkaline earth metal borohydride is selected from the group comprising of magnesium borohydride and calcium borohydride.
9. The process according to claim 1, wherein (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines and (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines are (S)-(+)-10,11 -dihydro- 10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide and (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide respectively.

10. The process according to claim 1, wherein (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines, (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines and 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines are (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide and 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide respectively.
11. The process according to any of the preceding claims, further comprising preparing (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-azepine, or (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-azepine from (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine, which are obtained by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine or derivatives thereof in presence of boronate esters.
12. A process for the preparation of optically pure (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide (V) or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide (Va) or prodrug esters thereof, comprising:

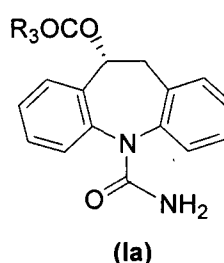
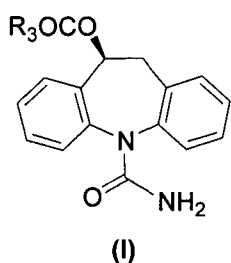


- a) reacting 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepine-5-carboxamide (II) with boronate esters or their derivatives in presence of borohydride compounds to obtain (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide;



b) optionally, if R₁ is not -CONH₂ group then converting R₁ to -CONH₂ to obtain the optically pure (S)-(+)- or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide;

5 c) optionally, converting compound obtained after steps 'a' or 'b' into their prodrug esters of formula (I) or (Ia);



wherein,

R₁ is CN, -CONH₂, -CONHP (P is protecting group), -COX₁ (X₁ is halogen) or -COOR₄;

10 R₃ is alkyl, halogenalkyl, aralkyl, cycloalkyl, cycloalkylalkyl, alkoxy, aryl or pyridyl; the term alkyl means carbon chain, straight or branched, containing from 1 to 18 carbon atoms; the term halogen represents fluorine, chlorine, bromine or iodine; the term cycloalkyl represents an alicyclic saturated group with 3 to 6 carbon atoms; and the term aryl represents unsubstituted phenyl group or phenyl substituted by alkoxy, halogen, nitro;

15 R₄ is acid protecting group such as alkyl, substituted or unsubstituted aryl or aralkyl group.

13. The process according to claim 12, wherein the reaction in the step 'a' for the preparation of (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines or (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepines is carried out by enantioselective reduction of 10,11-dihydro-10-oxo-5H-dibenz[b,f]azepines in presence of solvent

selected from the group comprising of ethers, amides, nitriles, sulfoxides, hydrocarbons (aliphatic or aromatic), chlorinated hydrocarbons (aliphatic or aromatic) and mixture(s) thereof.

14. The process according to claim 12, wherein boronate ester is selected from dihydroxy compound derived esters of boronic acid or their derivatives.

15. The process according to claim 14, wherein dihydroxy compound is tartaric acid or derivatives thereof.

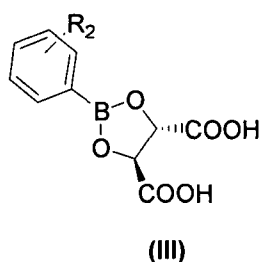
16. The process according to claim 14, wherein boronic acid is substituted or unsubstituted phenyl boronic acid.

17. The process according to claim 12, wherein, borohydride compound is selected from the group comprising of alkali metal borohydrides, alkaline earth metal borohydrides, transition metal borohydrides, tetra alkyl ammonium borohydrides, lithium aluminum hydrides and BH_3 -ligand complex.

18. The process according to claim 17, wherein alkali metal borohydride is selected from the group comprising of sodium borohydride, lithium borohydride, potassium borohydride, sodium cyanoborohydride and $\text{NaBH}(\text{OAc})_3$.

19. The process according to claim 17, wherein alkaline earth metal borohydride is selected from the group comprising of magnesium borohydride and calcium borohydride.

20. The process according to claim 12, wherein boronate ester is selected from compound of formula III;



wherein R_2 may be but not restricted to hydrogen, alkyl, aryl, halogen, alkoxy, aryloxy, nitro, cyano, acyl, acyloxy.

21. A pharmaceutical composition according to any of the proceeding claims comprising a therapeutically effective amount of compounds selected from (S)-(+)-10,11-dihydro-

10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, and (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide prepared according to the process of any of the preceding claims and one or more pharmaceutically acceptable carriers, excipients or diluents.

22. Use of a pharmaceutical composition according to any of the proceeding claims that includes a therapeutically effective amount (S)-(+)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, (R)-(-)-10,11-dihydro-10-hydroxy-5H-dibenz[b,f]azepine-5-carboxamide, (S)-(-)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide, and (R)-(+)-10-acetoxy-10,11-dihydro-5H-dibenz[b,f]azepine-5-carboxamide prepared according to the process of any of the preceding claims and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment of psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.

23. Eslicarbazepine having particles size distribution as $d_{0.9}$ less than 200 μm , $d_{0.5}$ less than 80 μm and $d_{0.1}$ less than 35 μm .

24. Eslicarbazepine acetate having particles size distribution as $d_{0.9}$ less than 200 μm , $d_{0.5}$ less than 70 μm and $d_{0.1}$ less than 20 μm .

25. Crystalline polymorphic form J_1 of eslicarbazepine.

26. The crystalline Form J_1 of eslicarbazepine, characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure I.

27. The crystalline Form J_1 of eslicarbazepine, characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure III.

28. A process for the preparation of Form J₁ of eslicarbazepine comprising removing organic solvent(s) from a solution of eslicarbazepine in water and organic solvent(s) in presence of excess of water.

5

29. Crystalline polymorphic form J₂ of eslicarbazepine.

30. The crystalline Form J₂ of eslicarbazepine, characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure V.

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31. The crystalline Form J₂ of eslicarbazepine, characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure VII.

15 32. A process for the preparation of Form J₂ of eslicarbazepine, comprising removing organic solvent(s) from a solution of eslicarbazepine in organic solvent(s) followed by treatment with water or mixture thereof with organic solvent(s).

33. Crystalline polymorphic Form J₃ of eslicarbazepine.

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34. The crystalline Form J₃ of eslicarbazepine, characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure IX.

25 35. The crystalline Form J₃ of eslicarbazepine, characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XI.

36. A process for the preparation of Form J₃ of eslicarbazepine, comprising obtaining eslicarbazepine from a solution of eslicarbazepine in a mixture of water soluble organic solvent and water.

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37. Crystalline polymorphic form J₄ of eslicarbazepine.

38. The crystalline Form J₄ of eslicarbazepine, characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure XIII.

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39. The crystalline Form J₄ of eslicarbazepine, characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XV.

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40. A process for the preparation of Form J₄ of eslicarbazepine comprising removing water miscible organic solvent(s) from a solution of eslicarbazepine in water and water miscible organic solvent(s) in presence of less amount of water.

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41. The crystalline Form of eslicarbazepine acetate, characterized by its X-ray powder diffraction ("XRPD") pattern substantially in accordance with the pattern as depicted in Figure XXI.

42. The crystalline Form of eslicarbazepine acetate, characterized by its Differential Scanning Calorimetry (DSC) thermogram as depicted in Figure XXIII.

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43. A process for the preparation of crystalline Form of eslicarbazepine acetate, comprising crystallization using a solvent or mixture of solvents or by removal of solvent(s) from a solution of eslicarbazepine acetate or by precipitation of a solution of eslicarbazepine acetate in organic solvent(s) using anti-solvent.

25

44. Use of Form J₁, J₂, J₃, J₄ or amorphous form of eslicarbazepine for the preparation of eslicarbazepine acetate.

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45. The pharmaceutical composition comprising therapeutically effective amount of novel crystalline Form J₁, J₂, J₃, J₄ or amorphous form of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents.

46. Use of a pharmaceutical composition comprising therapeutically effective amount of novel crystalline Form J₁, J₂, J₃, J₄ or amorphous form of eslicarbazepine and one or more pharmaceutically acceptable carriers, excipients or diluents to treat conditions in a subject, in need thereof such as for the treatment psychosomatic disturbances, epilepsy, trigeminal neuralgia, cerebral spasticity, affective brain disorder or nervous function alteration in degenerative and post-ischemic disease, bipolar disorder etc.
47. Amorphous eslicarbazepine.
48. The process for the preparation of the amorphous form of eslicarbazepine comprises of dissolving eslicarbazepine in one or more solvents; and recovering the eslicarbazepine in the amorphous form by the removal of solvent.
49. Amorphous eslicarbazepine acetate.
50. The process for the preparation of the amorphous form of eslicarbazepine acetate comprising the steps of
- a) dissolving eslicarbazepine acetate in one or more solvents; and
 - b) recovering the eslicarbazepine acetate in the amorphous form by the removal of solvent.
51. The process according to claim 50, wherein method for removal the solvent is selected from the processes comprising of spray drying, distillation under vacuum, roller drying, freeze drying and thin film drying.
52. The solvent according to claims 25-51 selected from the group comprising of alcohols, nitriles, ketones, esters, ethers, amides, dialkylsulfoxide, water or the mixtures thereof.
53. A water soluble organic solvent according to claims 25-51 is selected from the group comprising of alcohols, ketones, lower alkyl glycol ethers, dipolar aprotic solvents, sulfolane and cyclic ethers or mixture(s) thereof.

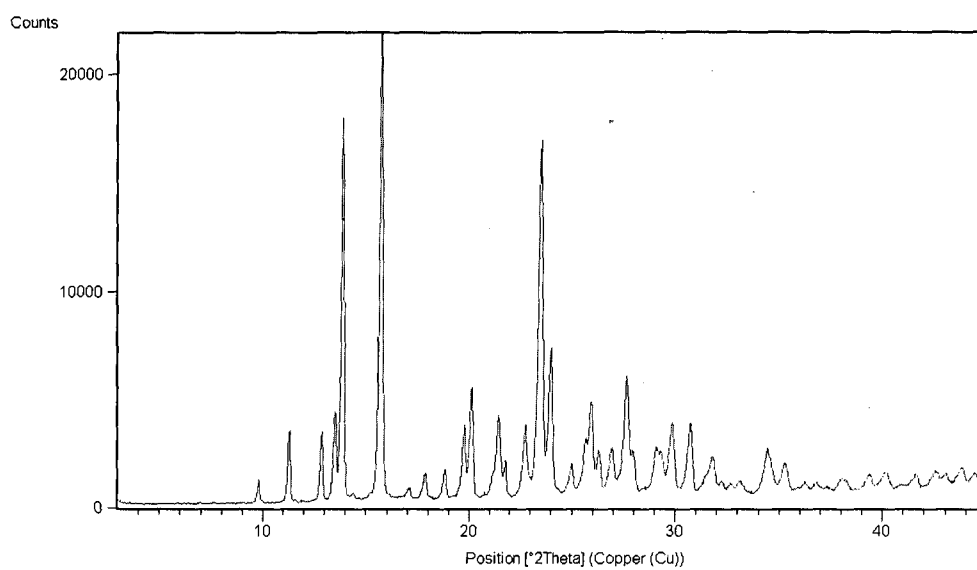
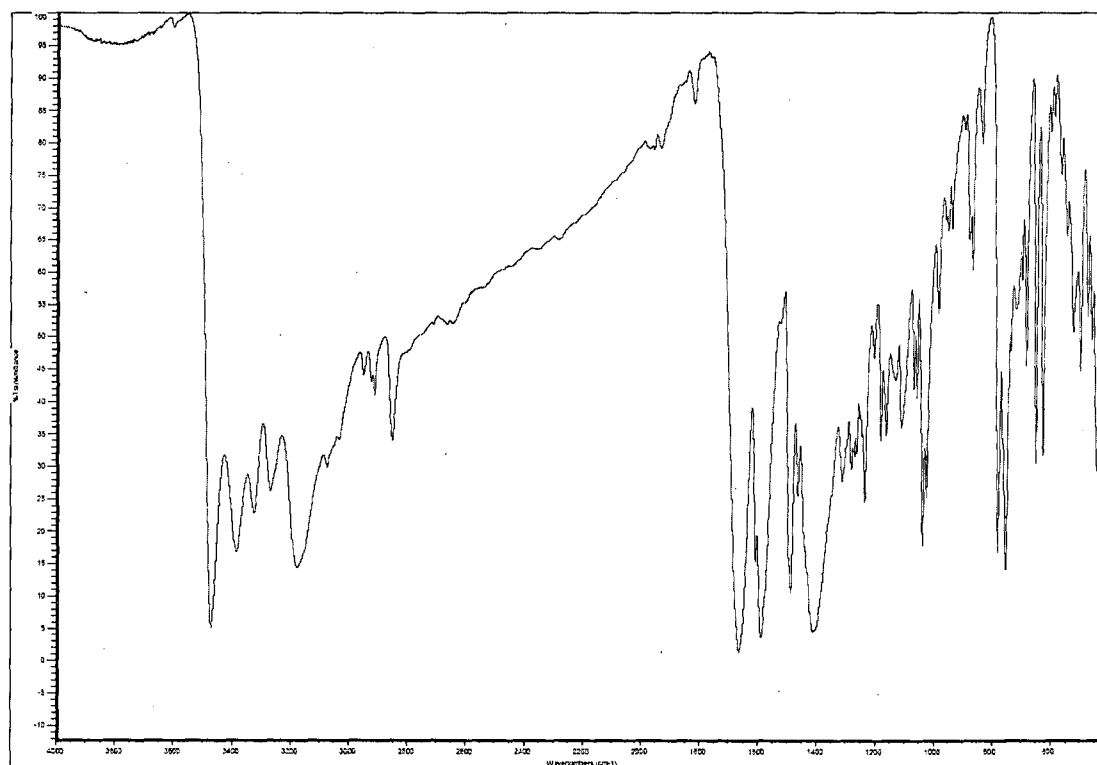
Figure I:**Figure II**

Figure III

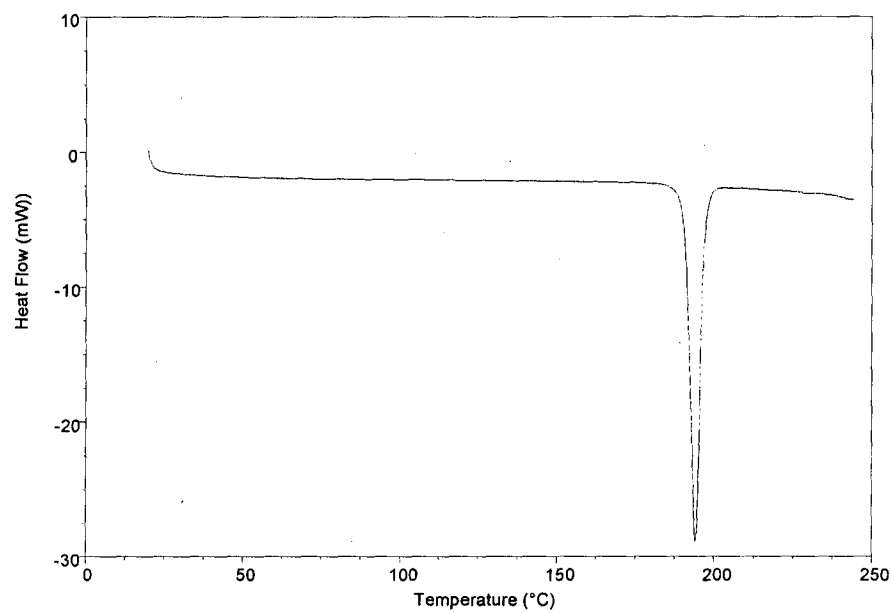


Figure IV

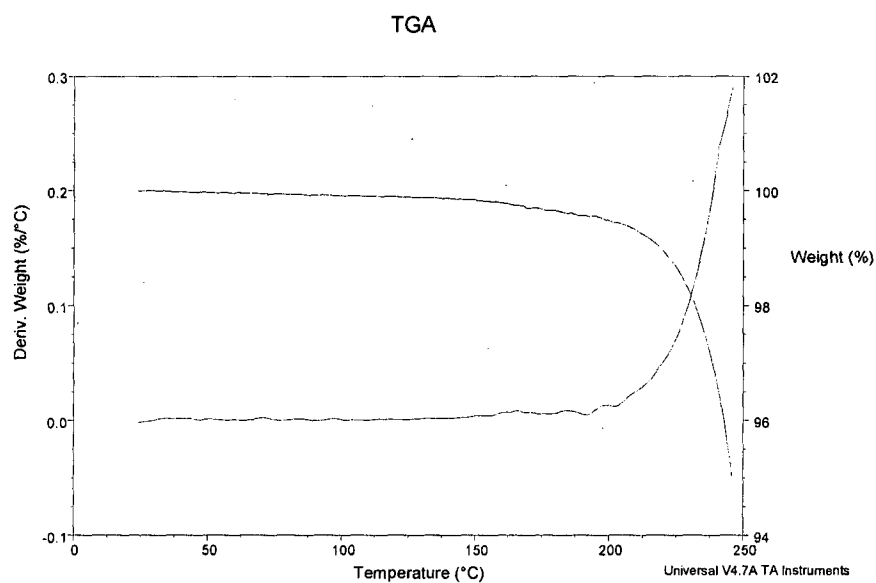


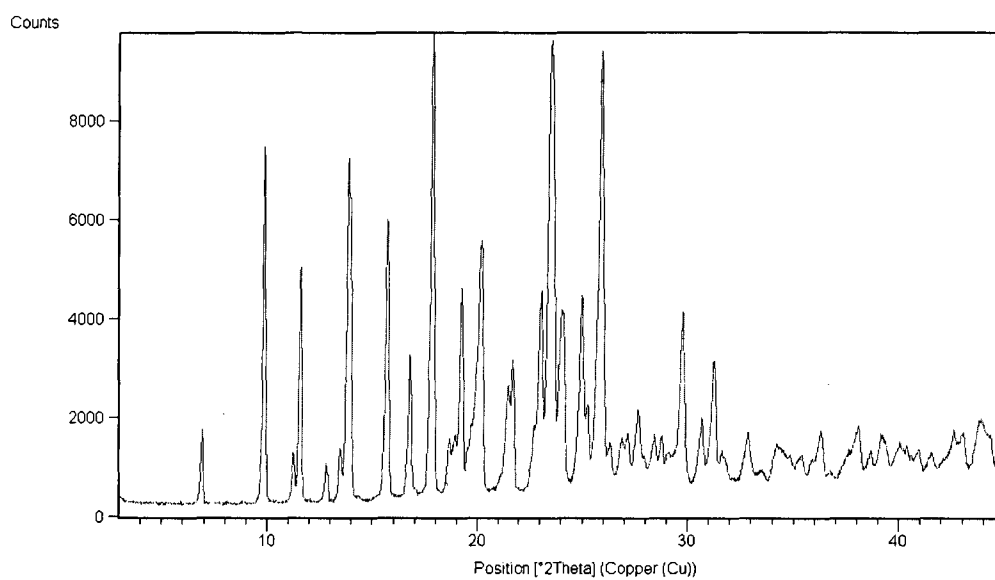
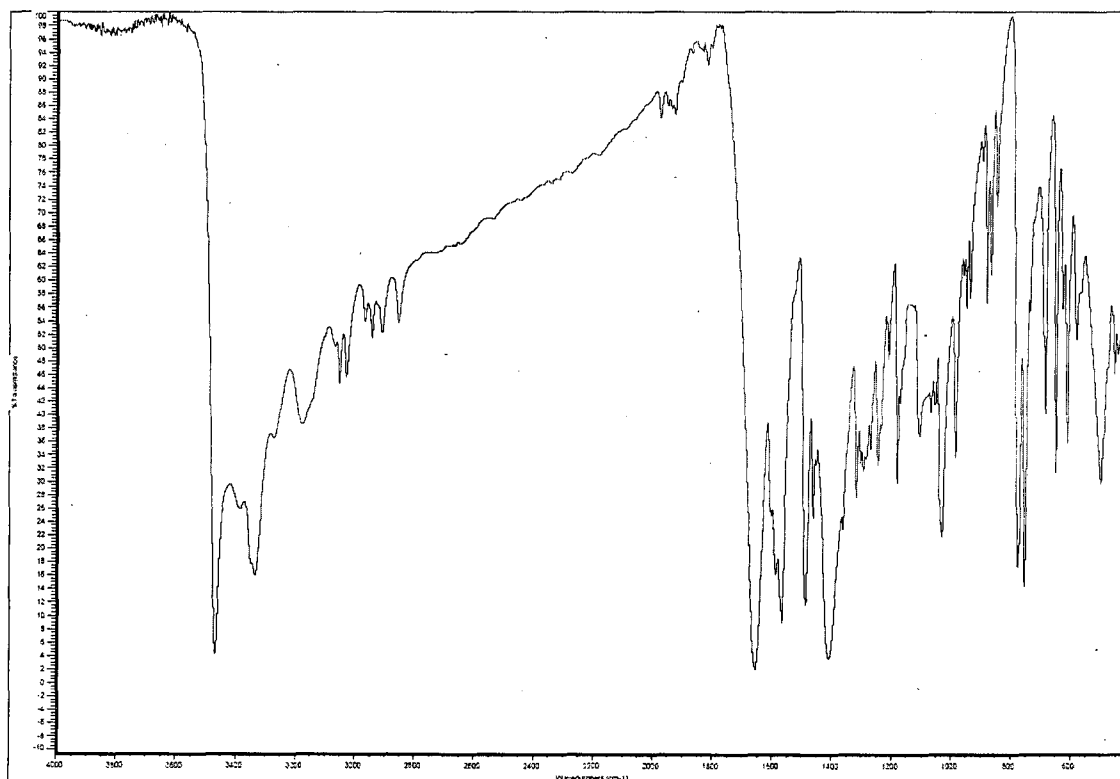
Figure V:**Figure VI**

Figure VII

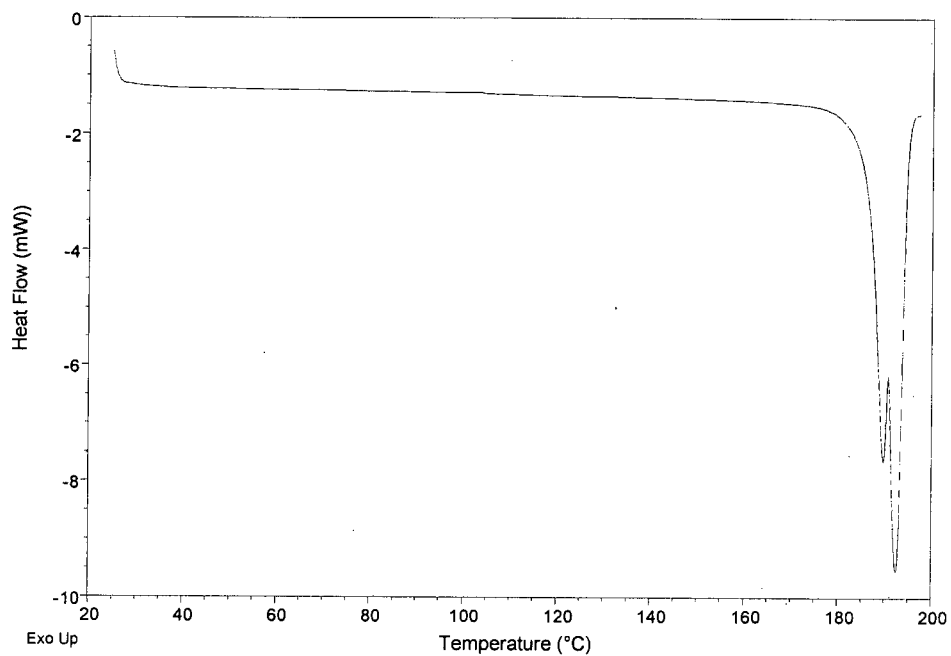


Figure VIII

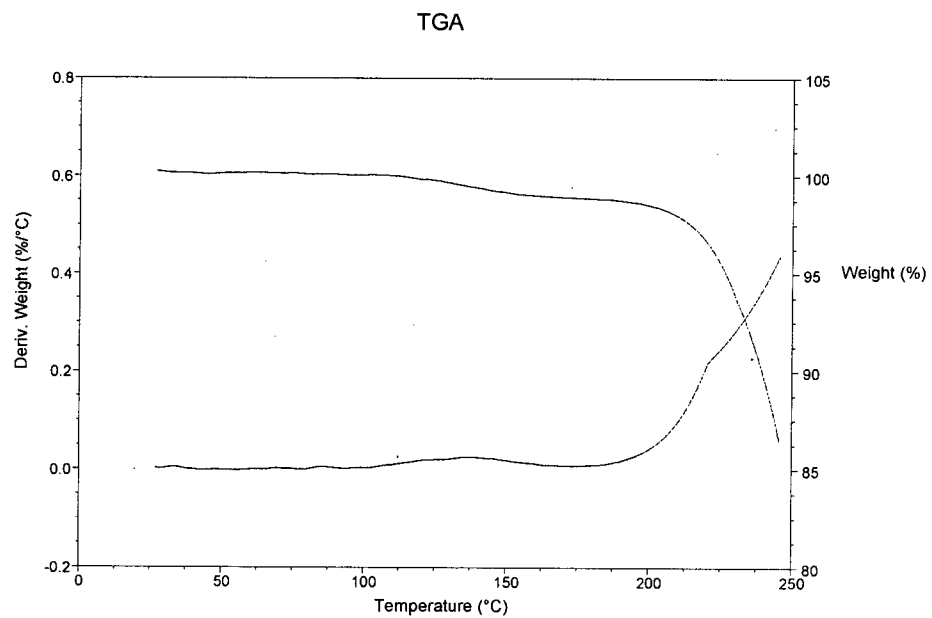


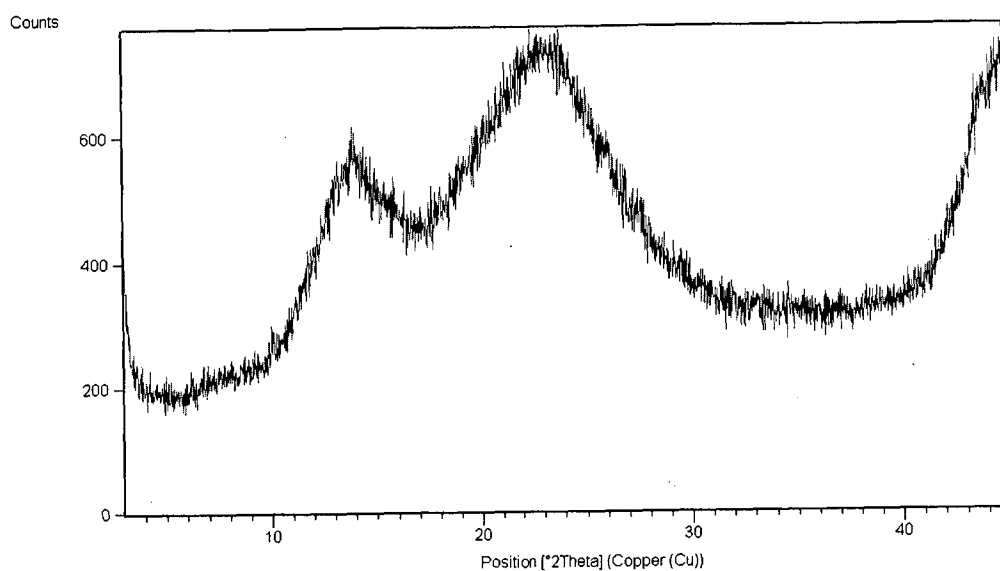
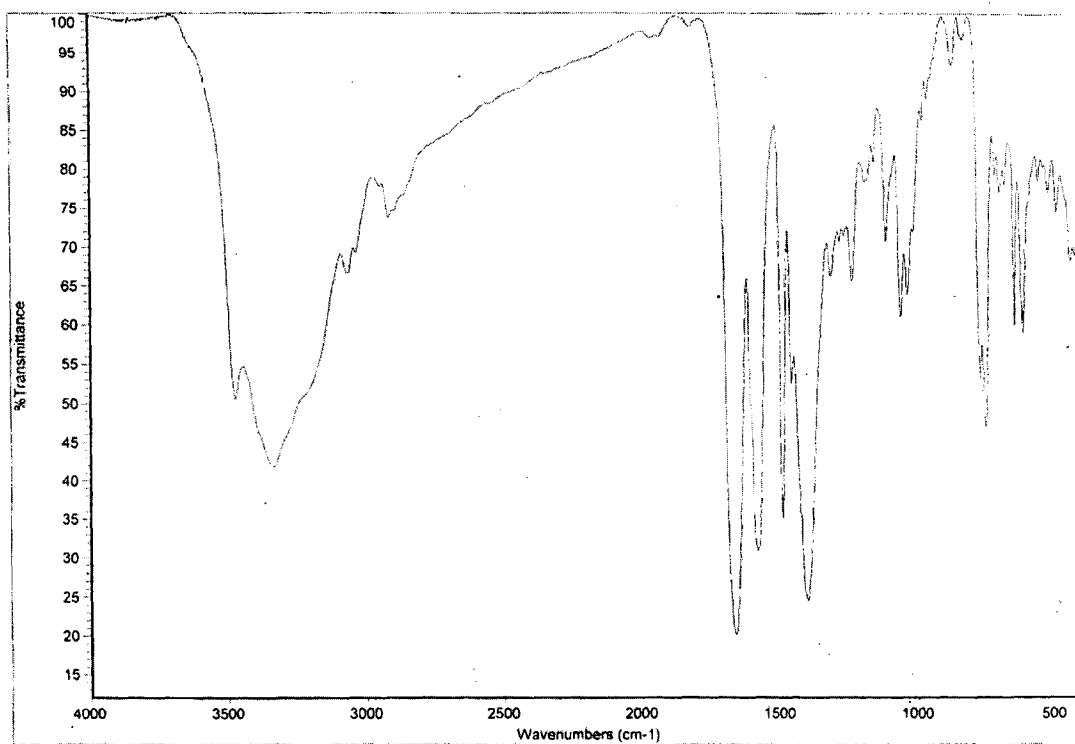
Figure IX:**Figure X:**

Figure XI:

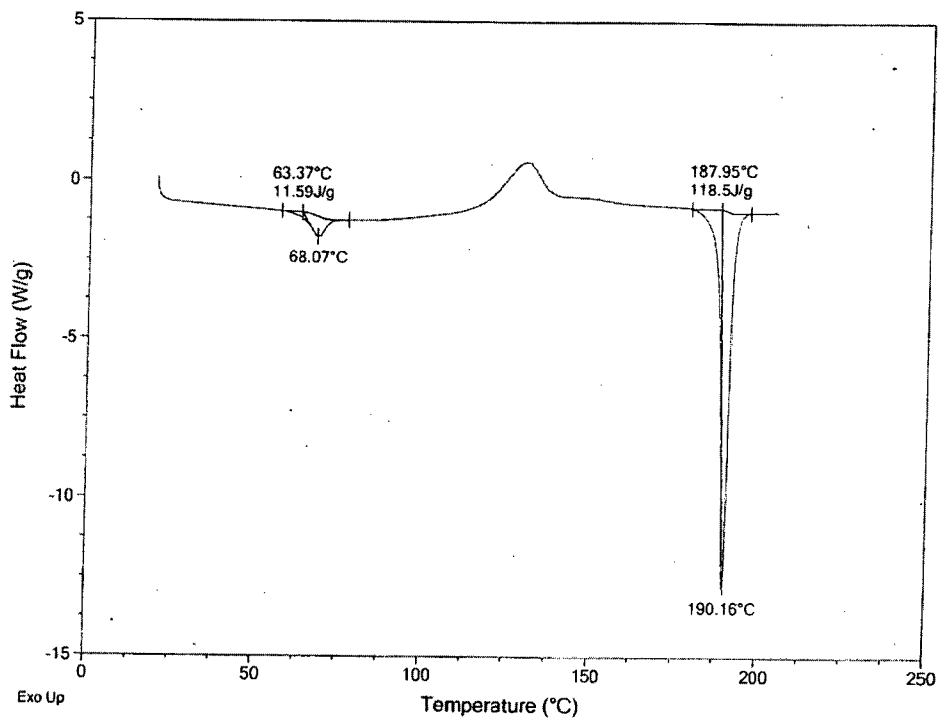


Figure XII:

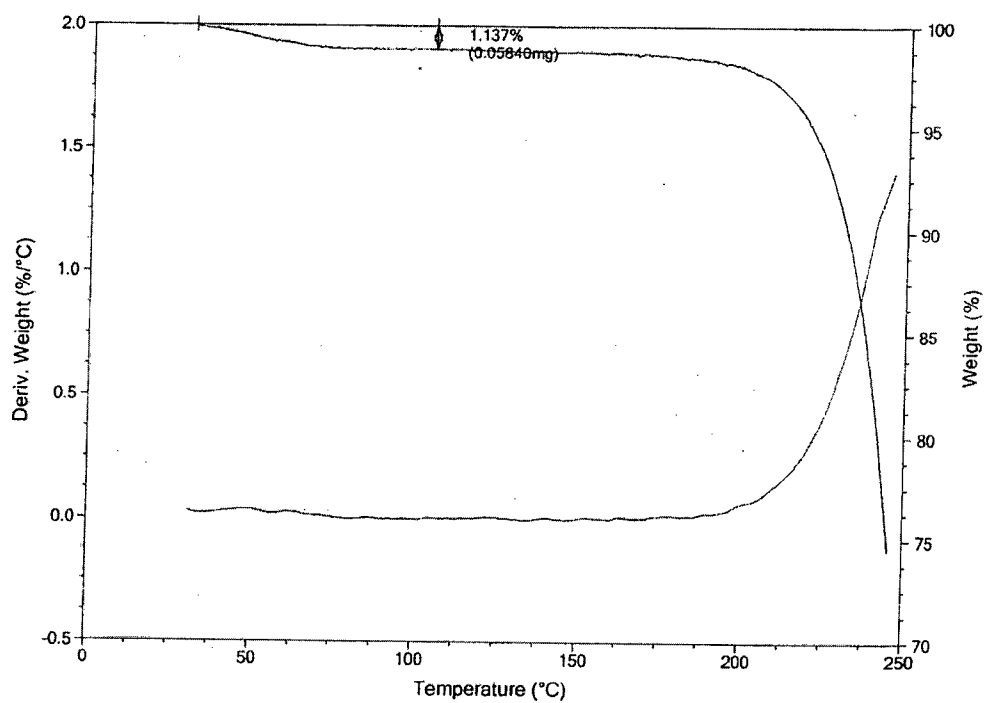


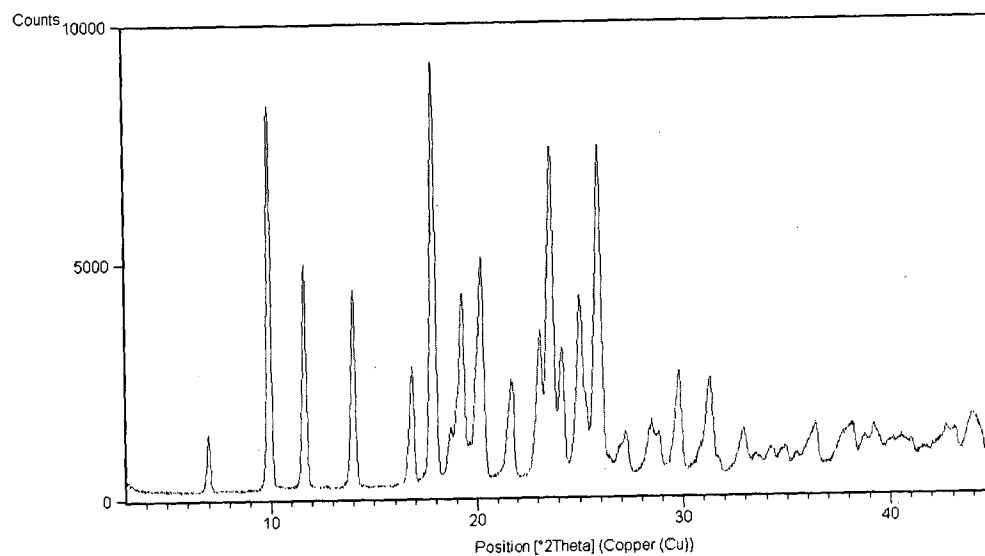
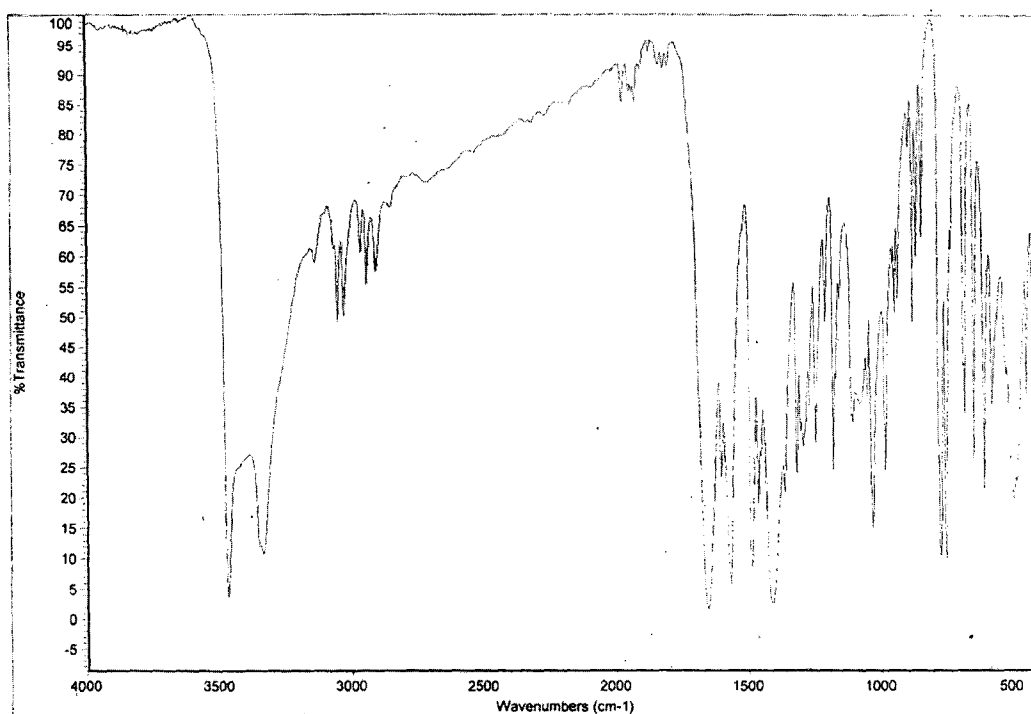
Figure XIII:**Figure XIV:**

Figure XV:

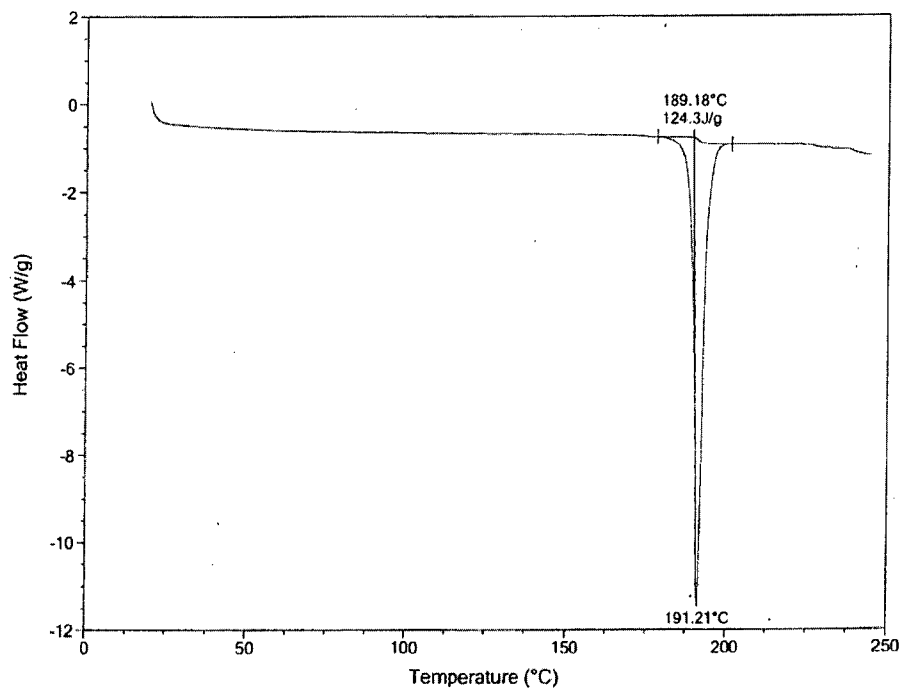


Figure XVI:

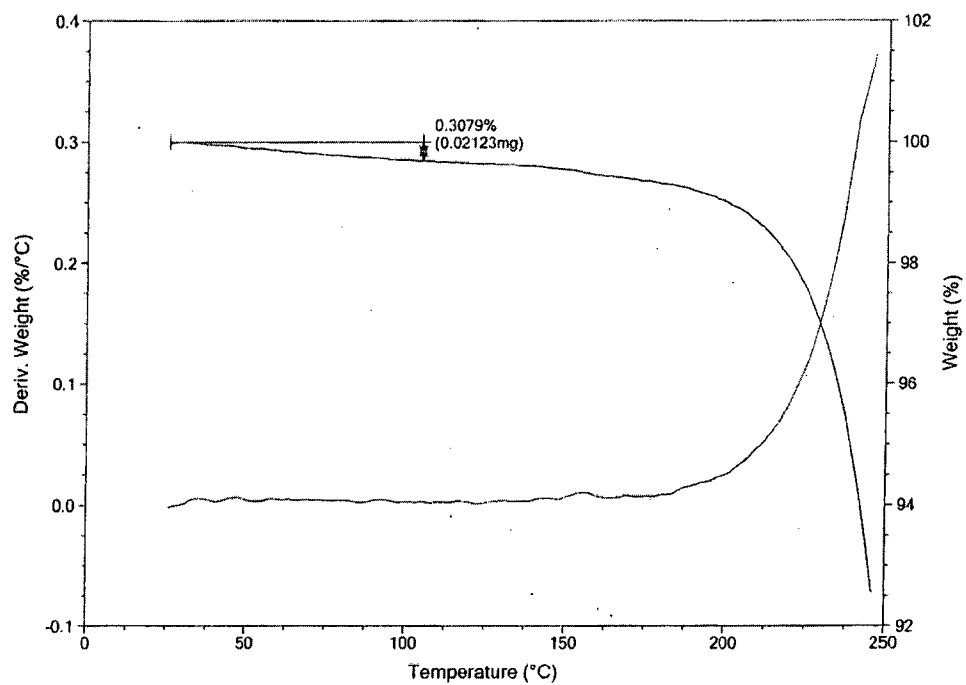


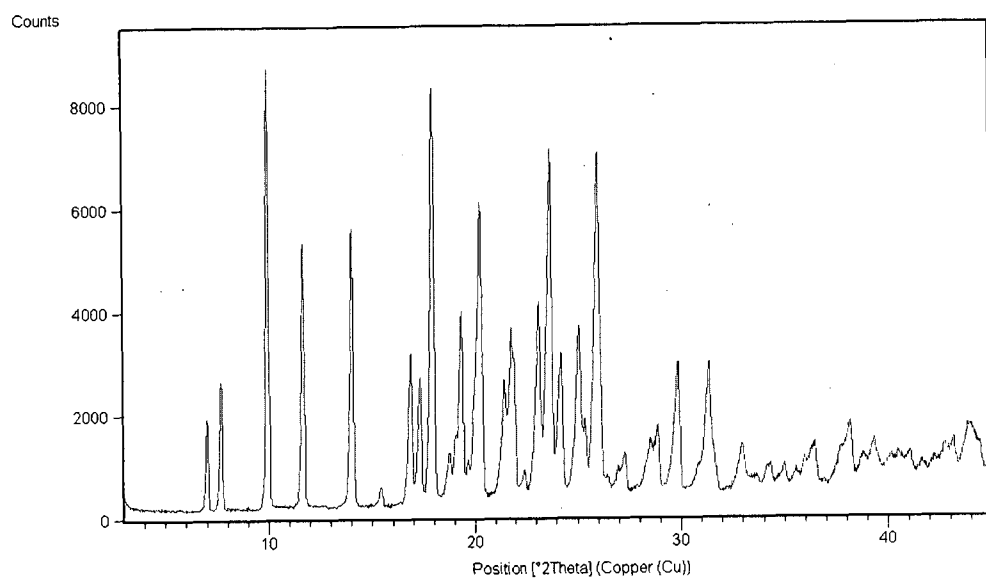
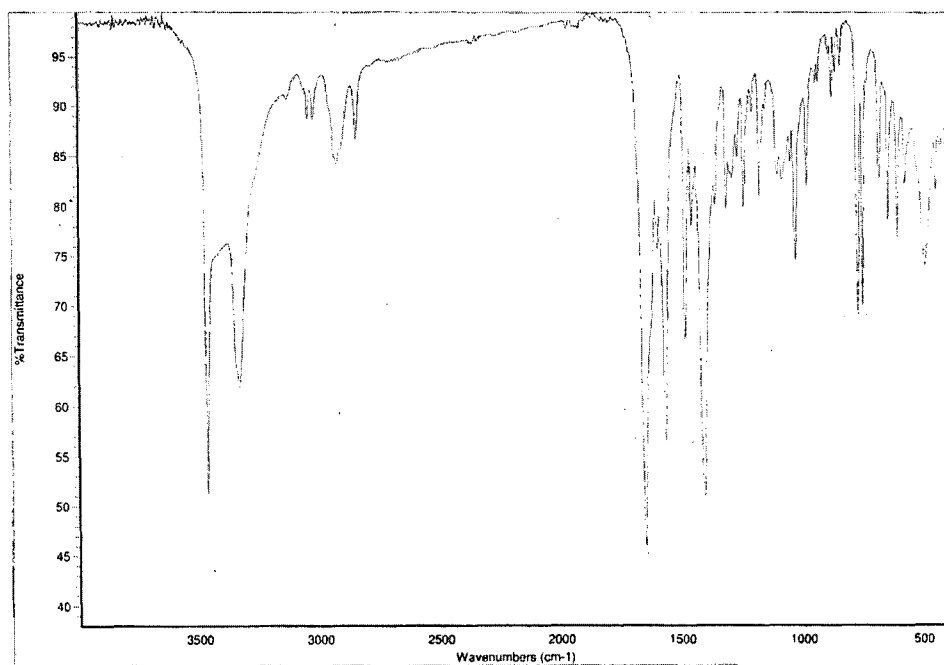
Figure XVII:**Figure XVIII:**

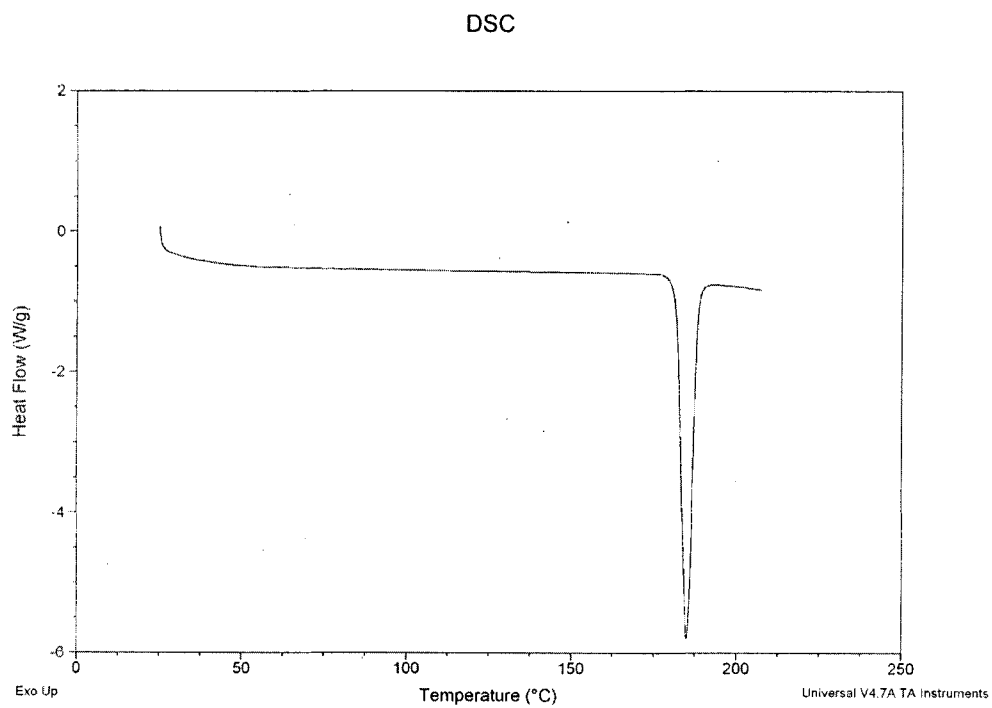
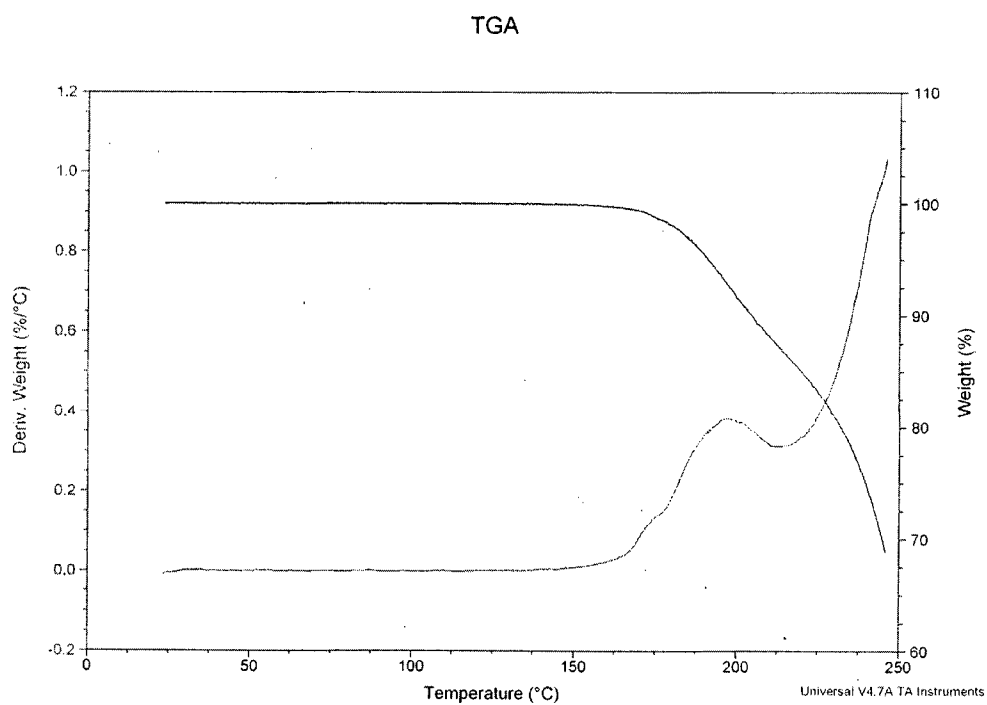
Figure XIX:**Figure XX:**

Figure XXI :

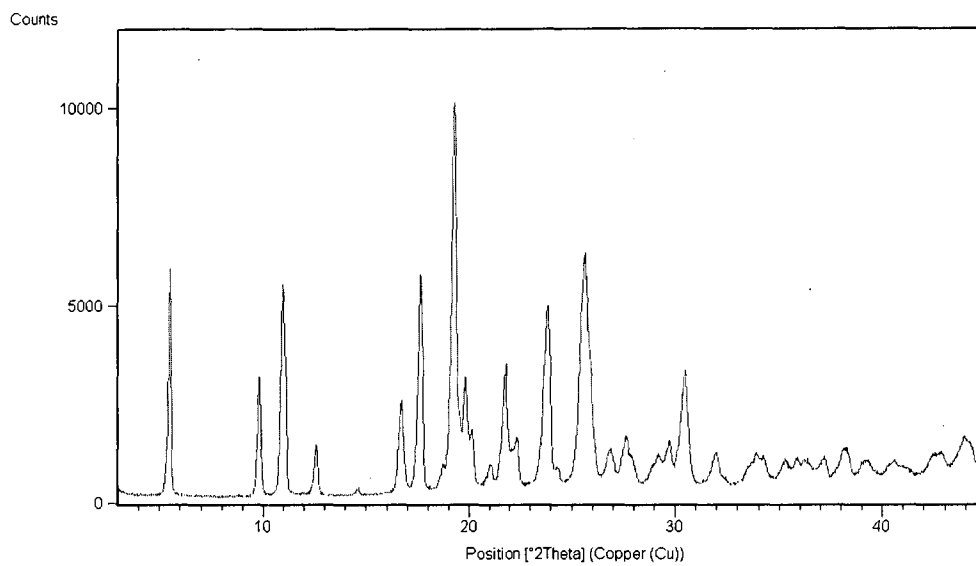


Figure XXII:

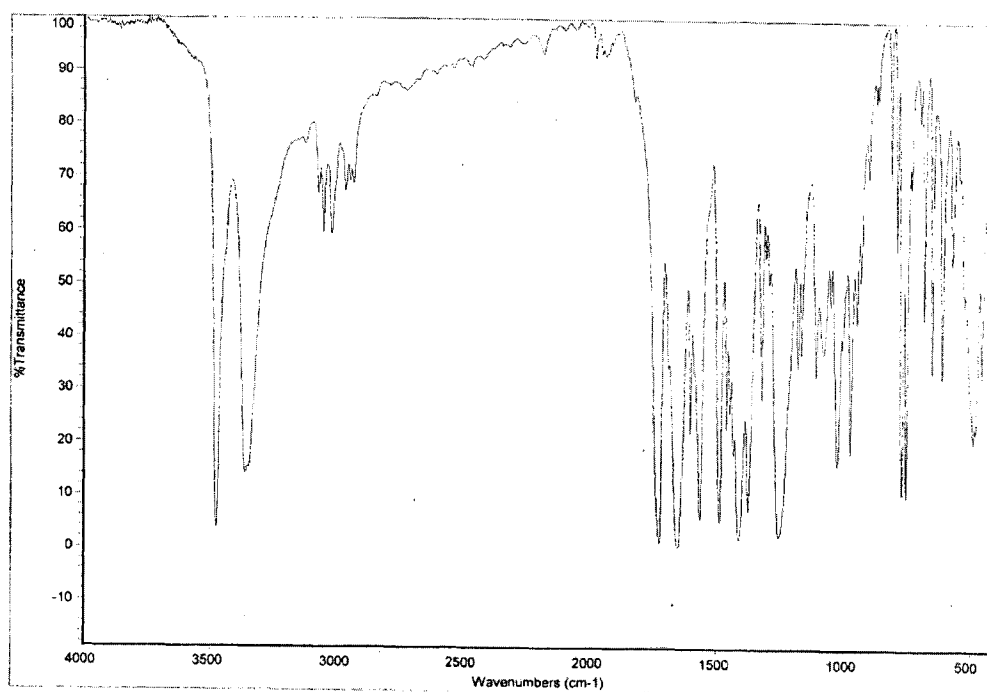


Figure XXIII:

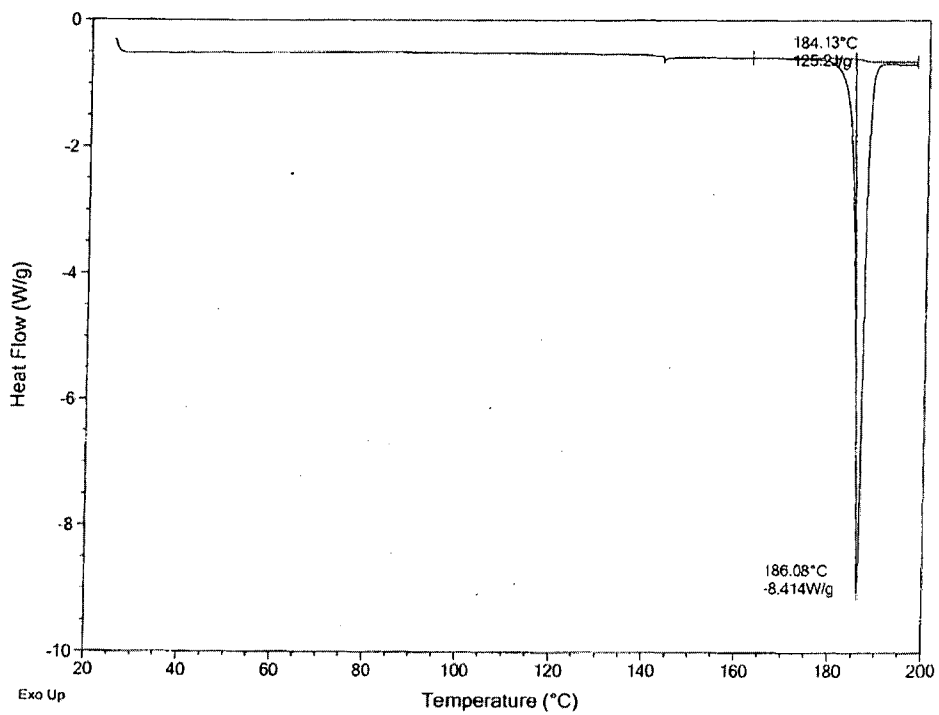


Figure XXIV:

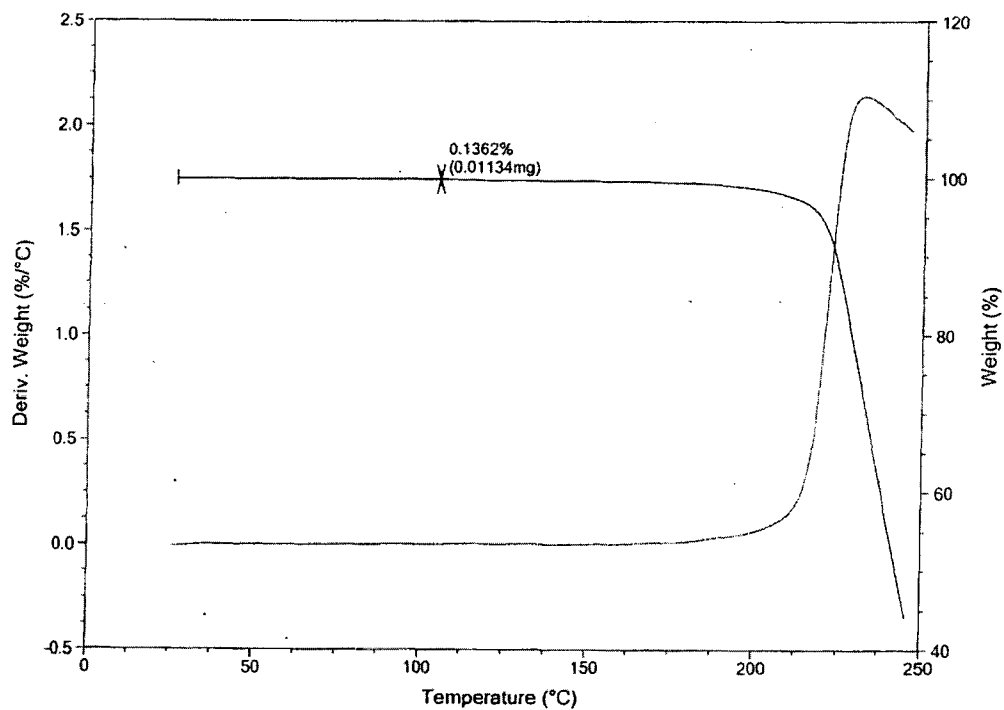


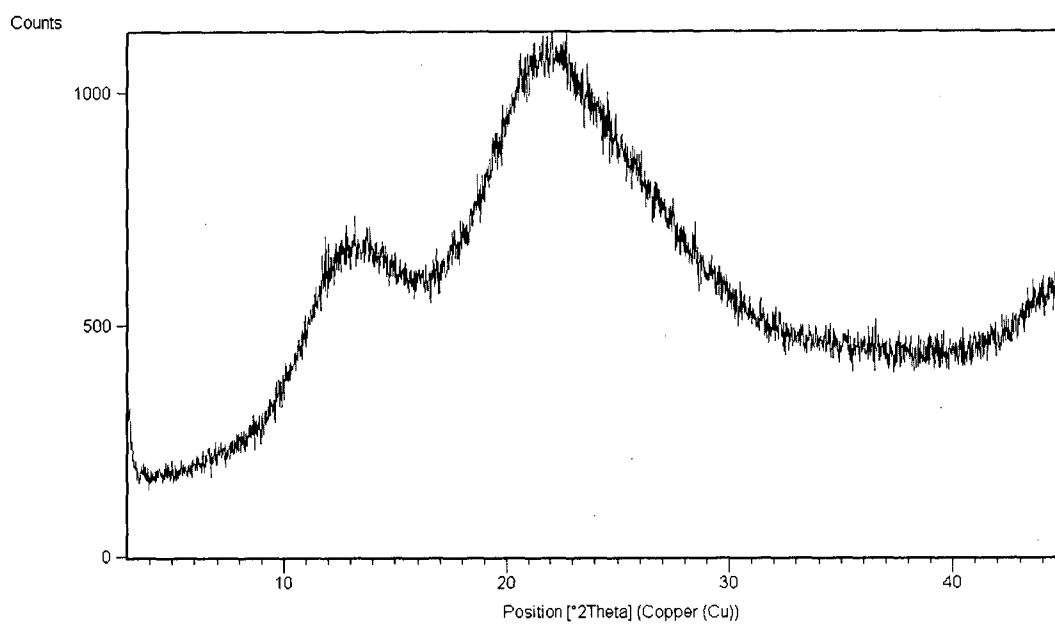
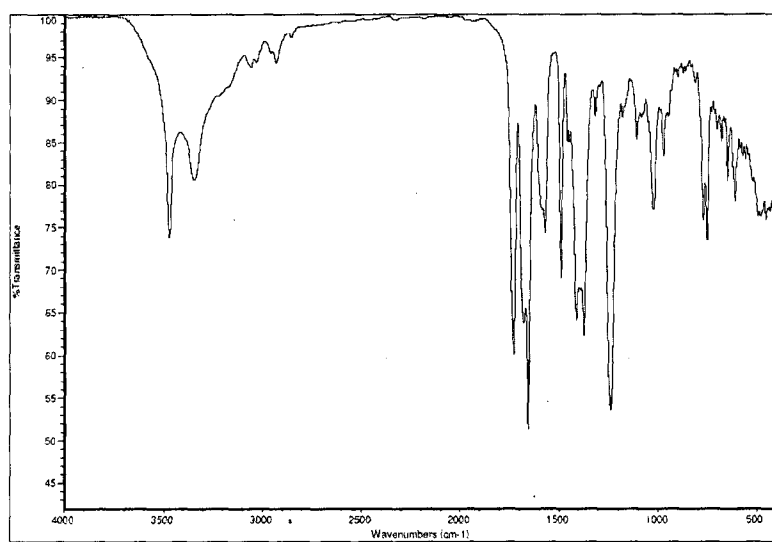
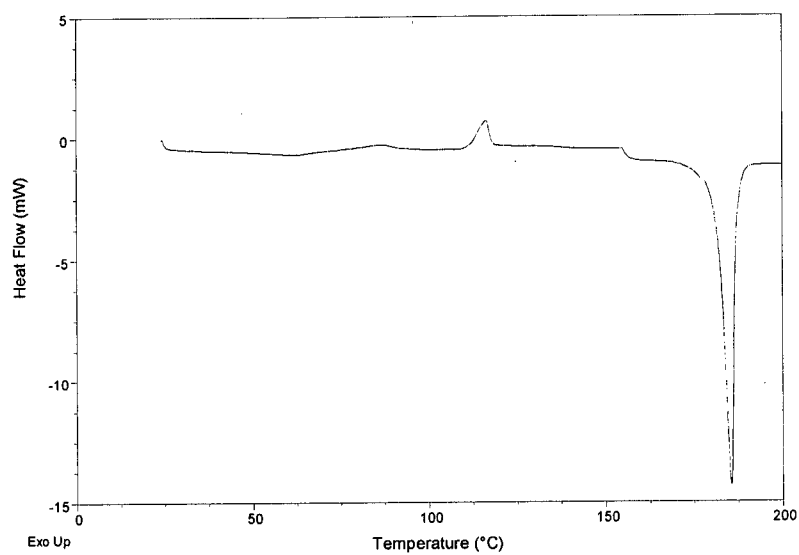
Figure XXV:**Figure XXVI :**

Figure XXVII :**Figure XXVIII :**