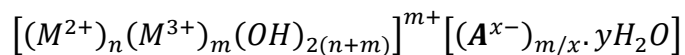


## CLAIMS

1. (Currently amended) A hybrid composite nanomaterial comprising a layered double hydroxide compound provided with one or more lanthanide elements inserted into the 2D layers and one or more organic compounds, having at least one of the functional group, from among the following: Hydroxyl (R-OH), Carbonyl (R<sub>1</sub>-C=O-R<sub>2</sub>), Carboxyl (RCOOH), Amino (RNH<sub>2</sub>), Phosphate (ROP(OH)<sub>2</sub>=O), Sulfhydryl (R-SH) and pertain to the class of Enzymes or Proteins, Porphyrin or Cannabis, intercalated between them.
2. (Currently amended) A hybrid composite nanomaterial of claim 1, comprising a layered double hydroxide compound provided with one or more lanthanide elements inserted into the 2D layers and one or more organic compounds having at least one of the entities, from among: Azole, Polybenzimidazole, Polythiophene, Fullerene, or acids (Perfluorosulfonic acid, Deoxyribonucleic acid, HEME B, Delta 9 TetraHydroCannabinol or Cannabidiol (CBD) or Coumarin-3-carboxylic acid (Coumarin) or Fluorescein) or salts thereof, and pertain to the class of Enzymes or Proteins, Porphyrin or Cannabis, intercalated between them.
3. (Currently amended) The material of claim 1 or claim 2, wherein the lanthanide elements are selected from a group consisting of Nd<sup>3+</sup>, Sm<sup>3+</sup>, Eu<sup>3+</sup>, Gd<sup>3+</sup>, Er<sup>3+</sup>, Tm<sup>3+</sup> and Yb<sup>3+</sup>.
4. (Currently amended) The material of claim 1 and claim 3 or claim 2-3, wherein the layered double hydroxide compound is described by the empirical formula:



where M<sup>2+</sup> and M<sup>3+</sup> are metal cations, permissible also in their M<sup>+</sup>, M<sup>4+</sup> form, A represents a x-valent anion(s) as sought in claim 1 or claim 2, x is the charge of the anion and y is the number of interlayer water molecules.

5. (Currently amended) The use of material derived out of any of claim 1, 2, 3 or 4 wherein a typical nanoscale Photoelectrochemical Cell (PEC) features an intercalated or encapsulated light harvesting species (DONOR/ACCEPTOR pair), capable of dissociating neighbouring water through the *insitu* generated ‘sum’ potential, with simultaneous, adsorption of part of the evolved

hydrogen, at the 2D lamella containing oxide phases.

6. (Currently amended) The use of material of claim 5, wherein the intercalated or encapsulated DONOR/ACCEPTOR pair can be any combinations from those specified as in claim 1 or claim 2, with similar light harvesters grown directly on the layered double hydroxide 2D lamella, as in, Inorganic (Quantum dots or rods or tetrapods), or as metal oxides from M(I-IV) ion, inserted into the 2D lamella and oxidised with the dissolved oxygen; with intercalated entity as its sensitizers.

7. (Currently amended) A method for the production of a hybrid composite nanomaterial, the method providing a single step one-pot synthesis of insertion of one or more lanthanide elements into the 2D layers of a hydrotalcite like-layered double hydroxide compound via a self assembly process occurring in the presence of chelating organic compounds having at least one of the functional group, from among the following: Hydroxyl (R-OH), Carbonyl (R<sub>1</sub>-C=O-R<sub>2</sub>), Carboxyl (RCOOH), Amino (RNH<sub>2</sub>), Phosphate (ROP(OH)<sub>2</sub>=O), Sulfhydryl (R-SH) and pertain ~~non~~ ~~exclusively~~ to the class of Enzymes or Proteins, Porphyrin or Cannabis, intercalated between them under hydrothermal conditions in a sealed container.

8. (**Original**) The method of claim 7, wherein hydrothermal conditions provide a synthesis temperature of between 80 °C and 150 °C.

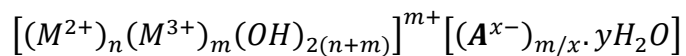
9. (**Original**) The method of claim 8, wherein hydrothermal conditions provide a synthesis time of between 8 hours and 12 hours.

10. (Currently amended) The method of claim 8, wherein the lanthanide elements are selected from a group consisting of Nd<sup>3+</sup>, Sm<sup>3+</sup>, Eu<sup>3+</sup>, Gd<sup>3+</sup>, Er<sup>3+</sup>, Tm<sup>3+</sup> and Yb<sup>3+</sup>.

11. (Currently amended) The method of any of claim 8, 9, 10, wherein the organic compounds have at least one of the functional group from among the following: Hydroxyl (R-OH), Carbonyl (R<sub>1</sub>-C=O-R<sub>2</sub>), Carboxyl (RCOOH), Amino (RNH<sub>2</sub>), Phosphate (ROP(OH)<sub>2</sub>=O), Sulfhydryl (R-SH) and pertain to the class of Enzymes or Proteins, Porphyrin or Cannabis.

12. (Currently amended) The method of any of claims 7 to 11, wherein the hybrid composite

nanomaterial compound is described by the empirical formula:



where  $M^{2+}$  and  $M^{3+}$  are metal cations, permissible also in their  $M^+$ ,  $M^{4+}$  form,  $A$  represents a  $x$ -valent anion(s),  $x$  is the charge of the anion and  $y$  is the number of interlayer water molecules.

13. (Currently amended) An organic-inorganic solar cell comprising a hybrid composite nanomaterial as in any claims from 1 to 5 combined with electrospun aligned functionalized electron transporting inorganic material(s) inserted into a conducting polymer matrix.

14. (Currently amended) The organic-inorganic solar cell of claim 13 configured as a three layers (111, 112, 113) co-axial electrospun organic-inorganic solar cell (110), wherein the electron transporting inorganic material comprises functionalized-Metal-Chalcogen-Halogen or functionalized/organically modified carbon based nano wires/tubes and further comprises a charge separation material provided in the bulk hetero junction as a middle layer (113), which in particular comprises at least of one fullerene derivative mixed with a light absorbing and efficient exciton generating polymer, such that phenomena like efficient light absorption/exciton dissociation at intra bulk hetero junction phase boundaries and efficient charge transport can take place in between the middle layer (113) containing the bulk hetero junction and the outer layer (112) hole transporting and inner layer (111) providing the innermost electron carrying structures of the three layers co-axial electrospun organic-inorganic solar cell, respectively.

15. (Currently amended) The organic-inorganic solar cell, of claim 14, wherein the organic-inorganic solar cell is configured as a tandem solar cell, by repeating a plurality of the active layers.

16. (Currently amended) The organic-inorganic hybrid cell, as in any of claims 13-15 combined with electrospinning or similar spinning techniques (e.g. Wet, Dry, Melt, Extrusion, Direct, and Gel Spinning) at micro or macro level, such that a Photoelectrochemical Cell (PEC) could be realized by incorporating oxygen emitting compounds into the (112) or (1112) anodic layer, for the oxygen evolution via water/aqueous electrolyte splitting, under an adequate generated potential, with possible subsequent storage of part of the evolved hydrogen gas, at the cathode (e.g. Nickel based alloy), into the locally dispersed adsorbents in the (1113) co-axial

chamber.

17. (Currently amended) The organic-inorganic hybrid cell, of claim 16, constructed separately, at macro scale keeping the same ideology, for dissociation of adsorbed water content from the aqueous electrolytic solution, in the (1112) anode layer; such that the relevant PEC-co-axial layers could be submitted to an adequate potential difference and hence its circuit could be completed with the electrons produced from the organic-inorganic solar cell, whereby part of the evolved hydrogen in the (1113) cathode chamber can be stored *insitu*, via locally dispersed adsorbents.

18. (Currently amended) The organic-inorganic hybrid cell, as in any of claims 16 and 17, wherein any additional power source, which can provide a net (local to oxygen emitter in the (1112) anode chamber) potential difference of  $>1.23$  V for water splitting, thereby evolving oxygen from the (1112) anode chamber and hydrogen from the (1113) cathode chamber, part of which is envisaged to be stored, *insitu*, into hybrid nanocomposite adsorbents dispersed locally.

19. (Currently amended) The organic-inorganic hybrid cell, as in any of claims 15-18, exploiting the plurality and hence the radial multi-stage co-axial chambers, thereby incorporating, *insitu*, at micro scale or separately at a macro scale, a Fuel Cell, with the electrodes made in line with the hybrid composite nanomaterial, to function as a catalyst for hydrogen or methanol/ethanol as fuel, and as an *insitu* hydrogen adsorbents, whereby, the excess, un-adsorbed Hydrogen as produced in any of the claims 5 and 16-18, could be consumed near their production site when coming in contact with the interfacial anode (1113/1111).

20. (Currently amended) The organic-inorganic hybrid cell, as in any of claims 5 and 16-19, wherein the anode, cathode and hydrogen adsorbents are synthesized as hybrid composite nanomaterials in line with claims 1-4 or claims 7-12 and dispersed along with: hole conducting nanomaterials into the (112) or (1112) chamber; while with electron conducting inorganic or carbon based nanomaterials in the (1113) co-axial chamber; whereas in the form of their dehydrated oxides, or as catalyzed RT hydrogen adsorbents in any of (112), (1112) or (1113); respectively.

21. (Currently amended) The organic-inorganic hybrid cell, as in any of claims 15-19, wherein the presence of the PEC and/or Fuel cell combination, into the remaining half of the co-axial plural layers.

22. (Currently amended) A method for the production of a Copper indium gallium selenide (CIGS) replica material which is provided with the intermediate structure:



by hydrothermal synthesis with  $\text{HSe}^-$  as major anionic species, generated *in situ* via  $\text{SO}_2$  and  $\text{NH}_3/\text{HCl}_{(g)}$  bubbling in the presence of  $\text{Al}^{3+}$  and  $\text{Na}^+$  ions, wherein consumption of 2D substituted  $\text{Al}^{3+}$  of a hybrid composite nanomaterial according to any of claims 1 to 4 to alumina is controlled by bubbling of  $\text{SO}_2$  gas into the reaction chamber for the *insitu* produced Se to react with  $\text{Al}^{3+}$  such that the CIGS replica material is rendered with its default p-type character; and wherein by a possible simultaneous re-addition of  $\text{In}^{3+}$  along with the gas bubbling; a submission of the solution mixture to a second step of high temperature, pressure and time, in specific:  $80\text{ }^\circ\text{C} \leq T \leq 150\text{ }^\circ\text{C}$ ,  $P$  as a function of  $[T, t]$  in a closed volume &  $8\text{ hrs} \leq t \leq 12\text{ hrs}$ , conditions, whereby the Al deficient compound is exposed to Indium/Sodium ions, such that the CIGS replica material is provided with a n-type character.

23. (Currently amended) The organic-inorganic solar cell of any of claims 14 to 19 or 21 including CIGS like/replica material as absorbing layer, creating an organic-inorganic solar cell with a material derived out of as in any of claims 1 to 4 and a material as obtainable from a method as in claim 22.

24. (Currently amended) The material derived out of any of claim 1, 2, 3 or 4 or that obtainable from a method as specified in claim 12 combined with Electro spinning or similar techniques (e.g. Wet, Dry, Melt, Extrusion, Direct, and Gel Spinning) as in claim 13, at micro or macro level, so as to produce porous co-axial host matrices, having the capacity to host any entities as mentioned in claim 1 or claim 2 and claim 6, for application as sensor or inhibitor or cure materials in medical field.