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Films based on titanium (TiO_2) and phosphorus (P_2O_5) oxides modified with reduced graphene oxide (rGO) with controllable photocatalytic properties and process to obtain them

Patent proposal: A/00342/2021

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Abstract:

The invention refers to a technology using the sol-gel method to obtain with reduced costs, vitreous films with photocatalytic properties based on TiO_2-P_2O_5 modified with reduced graphene oxide (rGO) to be used as anodes in dye-sensitized solar cell (DSSC). The prepared composite films exhibit the photocatalytic properties of titanium dioxide, the phosphorus characteristics to form vitreous structures, transparent, homogenous, with large active surface and large pore volume and the attributes of graphene oxide that improves the photocatalytic properties of titanium oxide.

Introduction:

The literature mentions a variety of types of TiO_2-based nanostructured photocatalyst for use in DSSC cells. This is due to the nanostructured TiO_2 especially the TiO_2 nanoparticles which have a larger surface area and consequently a higher loading capacity with organic dyes. On the other hand, the disordered TiO_2 lattice affects granule boundaries and weakens electron transport mobility resulting in high recombination of photoexcited electrons leading to lower overall DSSC performance [1]. Graphene is an alternative photoanodic material in DSSCs ideal for increasing the transport speed of the load due to its semimetal character with the increased transport speed of the load carriers (holes and electrons) with high electrical conductivity, optical, mechanical and thermal stability, corrosion resistance and coupled with electrocatalytic properties. Moreover, graphene is also considered a low-cost material to produce and offers outstanding transparency functions to allow maximum light absorption transfer along the TCO [2].

The invention eliminates the disadvantages of the known processes by increasing the TiO_2-P_2O_5-rGO composite directly on the Indium Tin Oxide (ITO) substrate, in a single step using a mixture of titanium and phosphorus precursors with reduced graphene oxide suspension, without using expensive and operable equipment in certain environmental conditions (e.g. advanced vacuum) for the production of electric, magnetic fields, or to produce accelerated electron or ion fluxes.

The technical problem solved by the invention relates to the synthesis method, by preparing by a green synthesis path and low costs of some TiO_2-P_2O_5-rGO coatings with superior optical and photocatalytic properties as a result of combining the photocatalytic properties of TiO_2 with the semimetal properties of reduced graphene oxide (rGO) and the optical properties of the vitreous matrix of titanium oxide and phosphorus pentoxide.

The advantages of the process according to the invention refer to the replacement of techniques with relatively high costs and pollutants requiring high vacuum, expensive equipment for producing electric and magnetic fields, accelerated electron flux or accelerated ion flux with a green synthesis path and low costs. processing.

Results:

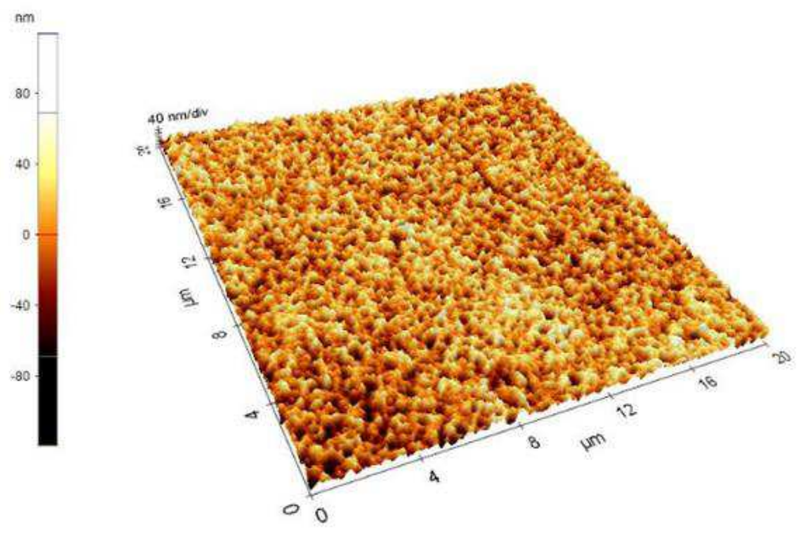

Figure 1. AFM image of the 1.5% rGO$TiO_2P_2O_5$ film

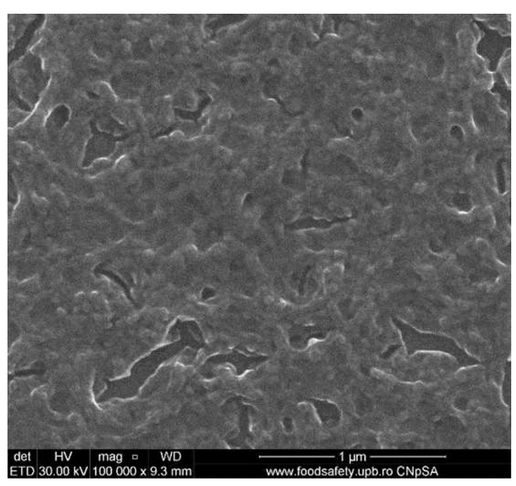

Figure 2. SEM image of the 1.5% rGO$TiO_2P_2O_5$ film

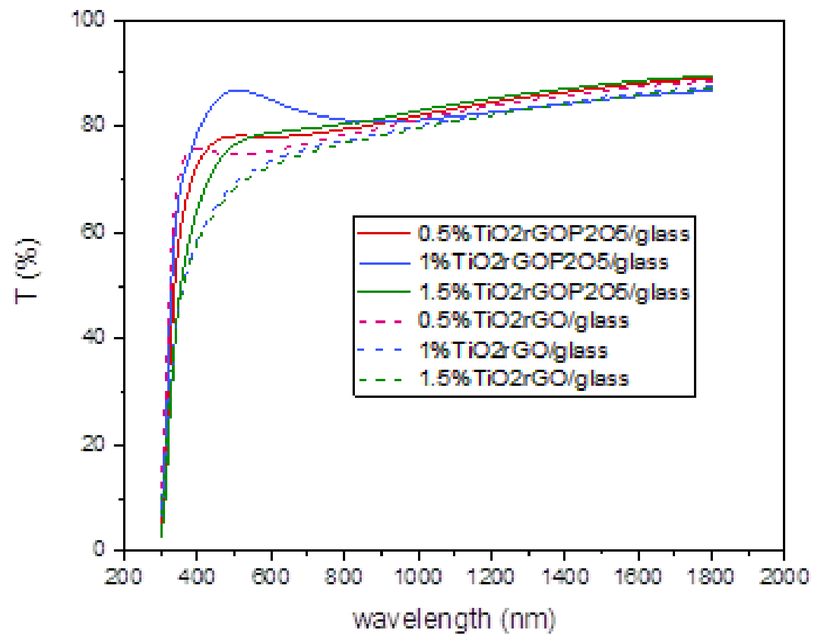

Figure 3. UV-Vis-NIR spectra of TiO_2rGO and TiO_2rGOP_2O_5 thin films on glass substrate at different concentrations of rGO in precursors mixture solutions.

Conclusions:

The prepared composite films exhibit the photocatalytic properties of titanium dioxide, the phosphorus characteristics to form vitreous structures, transparent, homogenous, with large active surface and large pore volume and the attributes of graphene oxide that improves the photocatalytic properties of titanium oxide.

The TiO_2-P_2O_5-rGO vitreous composite usable in DSSC cells as a photoanode offers outstanding transparency functions to allow maximum light absorption transfer along the photovoltaic cell.

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[2] Recent developments of graphene-TiO_2 composite nanomaterials as efficient photoelectrodes in dye-sensitized solar cells: A review Foo Wah Low, Chin Wei Lai ∗ Renewable and Sustainable Energy Reviews 82 (2018) 103–125