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Flexible, freestanding, and functional electro spun nanomaterials for dye-sensitized solar cell and photocatalytic dye degradation

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Metal oxide nanomaterials have attracted growing interests for applications in energy conversion and storage applications (e.g., photovoltaics, water splitting, photocatalysis, hydrogen storage, and Li-ion batteries) due to their optical/electrochemical properties, chemical/environmental stability, and cost-effectiveness. In this talk, I will present our studies on the SiO_2 nanofibrous nonwoven mat prepared by electrospinning as a porous and high-temperature durable substrate for preparation of the freestanding, flexible, and multifunctional composites and their applications in the dye-sensitized solar cell (DSSC) and photocatalytic dye degradation. The neat SiO_2 nanofibrous nonwoven mat (denoted as SiO_2-NF) and the SiO_2 mat functionalized with gold nanoparticles (denoted as Au@SiO_2-NF) were readily prepared by electrospinning of spin dope containing precursors. Subsequently, a patterned layer of TiO_2 nanoparticles was impregnated and transferred into the SiO_2 or Au@SiO_2-NF nonwoven mats. The freestanding composite mats of TiO_2 nanoparticles and electro spun SiO_2 NF or Au@SiO_2-NF (denoted as TiO_2-NP/SiO_2-NF or TiO_2-NP/Au@SiO_2-NF, respectively) were demonstrated for DSSC and photocatalytic dye degradation. By controlling the amount of TiO_2, composite mats with only partially filled TiO_2 nanoparticles on one side were used as photoanode and spacer in DSSCs; the device had an efficiency of 5.31%. Incorporation of Au nanoparticles in the photoanode (TiO_2-NP/Au@SiO_2-NF) improved the device performance. The thermally durable and freestanding TiO_2-NP/SiO_2-NF or TiO_2-NP/Au@SiO_2-NF were also used as readily recyclable and regeneratable materials for effective photo-degradation of the methylene blue in aqueous solution.

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