Titanium Dioxide Nanostructures Produced Using Geogenic Ilmenite for Photovoltaic Applications

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Nano-structured materials have become a prominent research topic in recent years due to their numerous distinguishing characteristics. Among all the transition metal oxides, TiO_2 is a compound of great importance due to its remarkable catalytic and distinctive semiconducting properties. Nano TiO_2 can be used as a strong oxidizing agent with a large surface area which implies high photo-catalytic activities. Some extensive research studies on the modification, preparation, and characteristics of nanomaterials have been published, allowing us to keep track of progress in this sector. In the case of the synthesis of pure TiO_2, the two main procedures, such as sulfate and chloride processes, are employed where both require concentrated corrosive acids and extreme temperatures, such as 1000 °C, in open operations, which resulted in significant expenses and pollution. Recently, a closed method has been developed, including rotatory autoclaving, refluxing, and stationary solvothermal treatment of ilmenite below 170 °C, which can be used to reduce costs and environmental effects. The as-synthesized product is 100% pure titanium dioxide in its amorphous state (24% crystallinity). This can be converted into over 99% pure anatase phase with 90% crystallinity and 100% pure rutile phase nanorods with 98% crystallinity by calcining at 350 and 650 °C, respectively. The direct band gaps of the three materials are 3.40, 3.60, and 3.15 eV, respectively. So, the new method can be used to modify the previously existing technology by using newly established processes for three phases in rutile, anatase, and amorphous state. As the world is progressing towards more ecologically friendly and sustainable energy, this procedure might be applied to the synthesis of pure TiO_2, where the substance can be employed in solar cell fabrication because solar cells are still encountering scientific and technological challenges in their commercialization.

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