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Strontium Titanate photocatalyst: Life Cycle Assessment on different Synthetic Routes

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Extended Abstract

Strontium titanate is a perovskite-type ceramic with excellent properties for numerous applications such as solar cells and gas sensors. A wide energy band gap (3.2 eV) similar to TiO_2, its thermal stability, and corrosion resistance are some features, making it promising candidate for photocatalytic application under UV irradiation [1]. Moreover, its potential has been recently investigated for the photocatalytic degradation of pollutants and energy storage [2, 3]. Despite the great interest on this material, there has been no emphasis on its sustainable development, fabrication, and environmental impacts. Therefore, a laboratory-scale life cycle assessment (LCA) analysis was performed to compare the environmental impacts of $SrTiO_3$ obtained via six representative synthetic routes (cradle-to-gate). These routes were broadly divided into two categories: with and without thermal treatment. In the former scenario, ultrasound-assisted, sol-gel, and solid-state method were selected. Whilst, hydrothermal, molten salt, and solvothermal methods were considered as bottom-up synthesis strategies without calcination stage [4]. Lastly, the best case scenarios were assessed in order to provide a sustainable and greener strategy for $SrTiO_3$ photocatalyst production.

In the scenario without thermal treatment, molten salt and hydrothermal synthesis procedures demonstrated considerable negative impacts, especially on Human toxicity (cancer effects) and Freshwater toxicity. These environmental effects were attributed to the energy consumption employed for long periods of time. On the other hand, ultrasound-assisted method critically influenced on human health and resources. This could be explained by the high electricity consumption requirements during both reaction and heat treatment stage. In addition, sol-gel technique affected adversely human health category, which is related to the use of different reagents employed during the synthesis process. Finally, the best case scenarios (solid state reaction and solvothermal methods) were assessed. From this evaluation, it was deduced that solid-state reaction can be proposed as an environmental friendly synthesis strategy for $SrTiO_3$ photocatalyst, which is a feasible industrial-scale process. Moreover, it is highly recommended to shift to renewable energy sources with the purpose of reducing numerous associated environmental impacts.

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