Reduction of SiO$_2$ nanopowder to Si nanopowder using household microwave oven

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Introduction

Widespread interest in the production of nanostructured silicon has put us on a journey towards the search for a better and cheaper synthetic process. Silicon has been used from various electronic devices to different energy-related applications such as in photovoltaics, batteries, and optoelectronic structures among others. In order to expand the usage of silicon, forming silicon nanopowders would enable for this material to be easily processed. For the past few years, there has been quite an interest in developing a process for the synthesis of silicon nanopowders and their various nanostructure forms. In this study, silicon nanopowders are synthesized from magnesiothermic reduction of silicon dioxide nanopowders using a typical microwave oven used at home. The method introduces an alternative low cost process for the production of silicon nanopowders. The process follows the chemical reaction [1]:

\[
\text{SiO}_2(s) + 2\text{Mg}(g) \rightarrow \text{Si}(s) + 2\text{MgO}(s) \quad \Delta G = -356.44 \text{ kJ/mol (at 600°C)}
\]

The key of using the conventional microwave oven as a heating platform is the material used in absorbing the microwave radiation and converting this to enough heat (good thermal conductor) for the reduction process to proceed. For this particular work, graphite (> 1 μm) was use as the microwave absorber material [2].

Methodology

In this study, Silicon nanopowder was successfully synthesized using a low-cost process following the magnesiothermic reduction reaction. This has been supported by data from XRD pattern and Raman spectra. Currently, the crystallite size obtained for this material is around 100nm. Future endeavors will focus on the control of the nanoparticle size through changes in reaction parameters.

Conclusion

In this study, Silicon nanopowder was successfully synthesized using a low-cost process following the magnesiothermic reduction reaction. This has been supported by data from XRD pattern and Raman spectra. Currently, the crystallite size obtained for this material is around 100nm. Future endeavors will focus on the control of the nanoparticle size through changes in reaction parameters.

Reference


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