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A New, Environmentally-Friendly Method for the Synthesis of Silicon Dioxide Using Oxalic Acid as a Catalyst

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ABSTRACT

In this study we have synthesized silicon dioxide with an environmentally friendly method, using a new catalyst which is oxalic acid as an intermediate for the hydrolysis phase with the possibility of recovery after the condensation phase. Water can be abandoned by relying only on ethanol as a chemically inert solvent with tetraethoxysilane. XRD, IR and UV analyses were used to determine the final product and to confirm the synthesis of silicon dioxide, the data obtained were compared with other research articles. The structure of the oxalic acid recovered after synthesis with a very high yield was proved by X-ray diffraction.

Keywords: Silica nanoparticles, Sol-gel process, Low environmental impact, Sustainable production

1 Introduction

It has been noted that nanotechnology is growing quickly, particularly in the field of materials engineering. Various nanoparticles are a good example, and current research in this area is focusing on their design, production, characterization, and applications. At the nanometer scale, the form and size of nanoparticles can affect their characteristics and specific functions. Chemical vapor deposition, arc discharge, hydrogen plasma-metal reaction, laser pyrolysis in the vapor phase, micro-emulsion, hydrothermal, sol-gel, and other techniques have all been reported for the synthesis of this materials [1]. Metal nanoparticles' properties are strongly affected by the process used to create them. Due to the safe, simple, cheap, and environmentally friendly synthesis technique used to synthesize metal oxide nanostructures, the scientific and research communities have recently shown a significant interest in these materials and their applications. In addition, because of their excellent surface-to-volume ratio and the quantum size effect, metal oxide nanoparticles exhibit unique electrical, optical, magnetic, chemical catalytic, and mechanical characteristics [2,3], This reflects the market's intense interest and the industrial need for metal oxides. The sol-gel precursors are mainly alkoxysilanes. They can be obtained with high purity (TEOS) and has been widely used as an inexpensive and less toxic precursor [4]. Very low reactivity in sol-gel reactions. As a result, the sol-gel process requires the interaction of a liquid alkoxide precursor, such as tetraethoxysilane (TEOS) with water in the presence of an acid or basic catalyst [5,6]. The precursor is first hydrolyzed in this method, and then the hydrolyzed species are condensed [7]. Using TEOS as a precursor, the following hydrolysis and alcohol and water condensation processes [7]

2 Experimental

The experimental synthesis section is based on the prospect of producing silicon dioxide through other studies showing the effectiveness of carboxylic chemical function in performing the role of an acid catalyst to initiate the hydration reaction. Inspired us to explore them in our study only depending on oxalic acid as a catalytic agent to produce identical chemical compounds to those in the reference articles.

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3 Results and Discussion

FTIR and XRD were used to better understand the chemical composition of SiO_2 nanoparticles produced by oxalic acid as a catalyst, as shown in Figure 1, both of them fit with most literature results

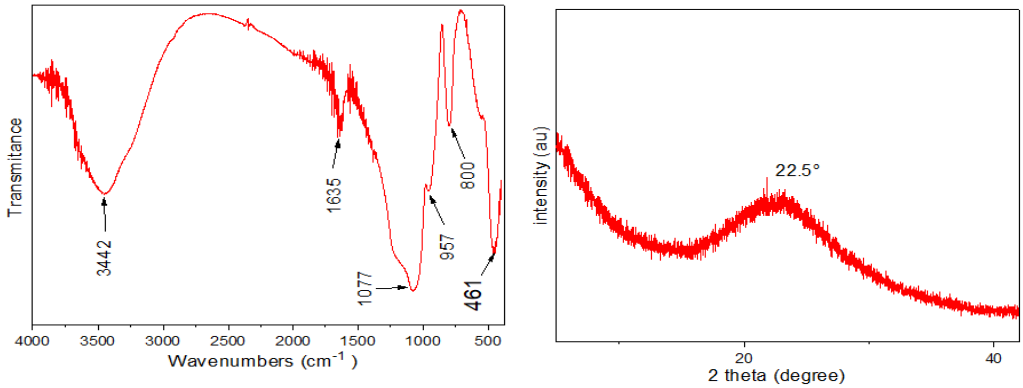

Figure 1: FTIR (a) and XRD patterns (b) of SiO_2 nanoparticles

4 Conclusions

silicon oxide can be manufactured by relying on oxalic acid as an effective catalyst for the reaction, as this catalyst can be recovered almost completely depending on the quality of the washing step, with the possibility of reusing it. This makes it compatible with environmental safety conditions and reduces the manufacturing cost significantly.

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