

A novel energy-efficient method to produce crystalline silica from burnt rice husk ash

Bandara N. G. H. J.¹, Madhushantha K. G. S.², De Silva C. R.², and Ratnaweera C. N.^{3*}

¹ Department of Chemistry, University of Ruhuna, Wellamadama, Matara, Sri Lanka.

² Sri Lanka Institute of Nano Technology (Pvt), Mahenwatta, Pitipana, Homagama, Sri Lanka.

³ Department of Chemistry & Physics, Western Carolina University, Cullowhee, USA.

* nadun@chem.ruh.ac.lk

The sol-gel method is efficient and sustainable for synthesizing high-purity silica from rice husks (RH), commonly available agricultural waste. Silica is a widely used material in various commercial applications for absorbing and retaining moisture. Producing commercial silica is costly and energy-intensive. In this study, we produced silica from rice husk ash (RHA) using the alkaline treatment. In the conventional alkaline treatment, silica is extracted as a water-soluble sodium silicate (Na_2SiO_3) solution by heating RHA with sodium hydroxide (NaOH). Then this solution is filtered and acid-treated until neutralization, until the silica aerogel is formed. In this work, we produced Na_2SiO_3 solution with 3M NaOH under 360 W microwave at 100 °C for 25 minutes. Silica aerogel is produced using the indirect neutralization method. Here, an excess of 1M Hydrochloric acid (HCl) was added to the Na_2SiO_3 solution to lower the pH to 2.5. Then, 1M NaOH was used to increase the pH back to 7, where the aerogel is formed. Silica yield was 74.4% from acid-treated

black rice husk ash. The FT-IR spectrum of RHA silica shows four major peaks. According to SEM-EDX and XRF, our RHA silica contains 82.21% silica. In contrast, all other elements, Al, Ca, Fe, Mn, and K, account for only 1.19% of the sample. The remaining 16.6% consists of sodium (Na) and chlorine (Cl), with no carbon residues detected in the sample according to TGA. The XRD analysis reveals sharp peaks at 2Theta values of 27.40°, 28.64°, 40.84°, 45.53°, 53.90°, 56.50°, 66.22°, and 75.34° indicating strong crystallinity with 78.38%. The particle size analysis revealed an average particle size is 15.99 μm. Microwave heating is used for alkaline treatment because it is more energy efficient compared to other heating methods. This proposed novel method produced crystalline silica from burnt rice husk ash without requiring high-temperature heating.

Keywords:

Burnt rice husk ash; sol-gel method; indirect neutralization; silica; crystalline