Silica synthesis from biomass: sustainable use of agroindustrial waste

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Agribusiness activities are generating large amounts of waste due to production processes and society's high consumption standard. The most common types of crop biomass waste are straw, bark, cob and bagasse. The amount of agricultural waste generated in the world (million tons/year) is: Rice husk: 130-170; Corn Cob: 164; Sugarcane Bagasse: 700. Most of this waste is disposed of by burning, dumping, or landfilling. Incorrect disposal raises serious questions related to human health and the environment, mainly associated with air pollution, water and soil contamination. The strategy to mitigate the effects of disposal is the reuse of agricultural biomass waste. Wastes such as rice husk, corn cob, wheat straw and sugarcane bagasse present high content of silica in the composition, thus can be utilized for the production of nanosilica (SiNPs). SiNPs present a variety of applications due to their distinctive properties such as stability, biocompatibility, surface reactivity, tunable pore size, and high surface area. Extracting silica from agricultural waste is an excellent alternative to obtain high added-value products. Methods of extracting silica from agricultural waste are divided into thermal, biological and chemical. The chemical synthesis method has the advantage of size and shape control, as well as purity improvement. Among the chemical methods, SiNPs are mainly synthesized via a sol-gel polymeric route. The silica is extracted from the waste as sodium silicate, then treated with acid to convert it into a gel. A transformation occurs in colloidal suspension of sol into gel through 3D interconnecting network. The sol–gel technique allows control the size, distribution, and morphology of particles with a large specific area and high porosity. Pure amorphous silica was successfully extracted at a 99.1% from sugarcane waste ash. The synthesized SiNPs can be characterized by a combination of spectroscopic and chemical techniques, such as XRD, XRF, SEM, TEM, particle size distribution, N2 adsorption-desorption isotherms, TGA, and FTIR. In this approach, the adoption of the circular economy in agroindustrial waste management contributes significantly to the achievement of the Sustainable Development Goals (SDGs), specifically, SDG 12: "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse".

Author infomation:

Dr. Denise Alves Fungaro

Denise Alves Fungaro is a researcher at the Nuclear and Energy Research Institute (IPEN-CNEN/SP) in Brazil, with a Ph.D. in Chemistry from the University of São Paulo (1993) and post-doctoral experience at the University of Coimbra, Portugal, specializing in electrochemistry applied to the environment. Dr. Fungaro leads research projects that focus on converting waste into value-added materials like adsorbent materials, zeolites, biochar, nanosilica, and activated carbon. She also explores the use of waste in green roofs and cementitious matrices. As an academic advisor, she supervises students at various levels, including undergraduate, master's, doctoral, and post-doctoral fellows. Her research addresses the development and environmental application of materials derived from waste, including coal combustion by-products, sugarcane ash, agricultural waste, and aluminum industry waste. These materials are characterized and applied in areas such as wastewater treatment, carbon capture and sequestration, green roof substrates, and cement additives. Dr. Fungaro is a prolific author, with over 80 peer-reviewed journal articles and more than 240 citations in the Web of Science. She has an h-index of 9, reflecting the impact of her work. In summary, Denise Alves Fungaro is an expert in developing sustainable solutions for waste management through the synthesis of innovative materials. Her research transforms industrial and agricultural waste into valuable products for environmental remediation.

Lecture date: 07/11/2024
Time: 15:30-16:00 Virtual Room A
Moderator: Luis De Boni