Sugarcane Biomass Ash as a Renewable Source of Nanosilica

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Brazil is the largest producer of sugarcane in the world. In the harvest 2015/16, were produced 665.6 million of tons of sugarcane and generates several residues, among them straw and bagasse are considered the main residues [1]. In general, each ton of sugarcane generates between 250 and 270 kg of bagasse and 200 kg of straw and tips [2]. The burning of these residues generates 1-4% of ash with silica as main chemical compound, usually above 60% by mass. As this biomass ash contain a high content of silica, a way of extracting it has attracted the interest of researchers around the world [3].

In the present study a method for obtaining high purity nanosilica from sugarcane biomass ash was investigated. The extraction of sodium silicate was carried out by fusion process at 550 °C for 1 h, varying the proportion (w:w) of ash:NaOH (1:0.5, 1:1, 1:1.5 and 1:2) [4]. Experimental procedure can be resumed by the Equation 1 and 2:

$$2\ NaOH + SiO_2\ (\text{from sugarcane biomass ash}) \xrightarrow{\Delta} Na_2SiO_3 + H_2O \quad \text{(Eq. 1)}$$

$$Na_2SiO_3 + 2\ HCl \longrightarrow SiO_2\ (\text{pure nanosilica}) + 2\ NaCl + H_2O \quad \text{(Eq. 2)}$$

Raw ash material and synthesis products were characterized by XRD, FTIR-ATR, SEM and TG. SEM image of synthesized sample in the proportion of ash:NaOH (1:2) exhibited nanoparticles of silica with size nanometric between 50 - 500 nm (Fig. 1). FTIR-ATR analysis indicated the presence of three main bands: at 798 and 450 cm^{-1} are due to symmetric stretching of siloxane groups (Si-O-Si) and at 1060 cm^{-1} is due the Si–O–Si asymmetric stretching. XRD analysis showeda broad peak at 22° (2θ), a characteristic of silica in amorphous form,and the absence of any crystalline phase in the material due the presence of impurities, such as NaCl. In TG analysis,three stages of mass loss are observed. The first is due to the moisture loss (below 100 °C); the second corresponds to the loss of physically adsorbed water from the surface (100 to 160 °C) and, finally, above 500 °C is observed a mass loss due to the surface dehydroxylation reaction [5].

The results demonstrated that is possible to obtain nanosilica from sugarcane biomass ash in a simple way with high purity and yield. This procedure will make possibleto reduce environmental impact of the sugar and alcohol sector and adding value to the residue.

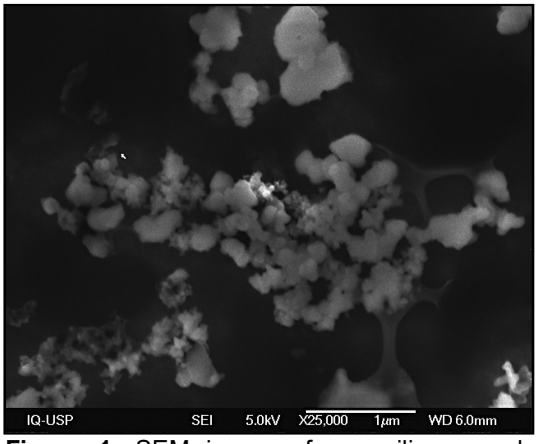

Figure 1. SEM image of nanosilica sample (ash:NaOH 1:2).

References:

1. Conab– Companhia Nacional de Abastecimento/Acompanhamento da Safra Brasileira – Cana-de-Açúcar, V. 2, SAFRA 2015/16, N.4, Quarto levantamento, ISSN: 2318-7921, 04/**2016**.
2. UNICA – União da Indústria de Cana-de-Açúcar/ Bioeletricidade 04/09/**2012**.
3. Noor-ul-Amin. *RSC Advances*, 4, 62769-62788, **2014**.
4. Hassan A. F., Abdelghny A. M., Elhadidy H., Youssef A. M. *Journal Sol-Gel Science and Technology*, 69, 465-472, **2014**.
5. Sexião H. You-Lo H. *ACS Sustainable Chemistry & Engineering*, 2, 726-734, **2014**.