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Growth Mechanism of Novel Sodium Carbonate Ribbon-Like Nanostructures

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Abstract - *Eucalyptus* sp. tar pitch arises, in recent research, as an interesting precursor to inorganic nanostructure growth. zinc nanowires, micro and nanospheres of tin and novel sodium carbonate nanoribbon were synthesized by copyrolisis of pitch and inorganic precursors [1]. In this study, the route was modified, and sodium carbonate nanoribbon was synthesized by heat treatment of sodium-rich pitch resin previously prepared [2]. The nanostructures were formed at around 500 °C (Fig. 1) by directional aggregation of Na_2CO_3 globular nanoparticles and the mechanism proposed considers that pitch resin confined de sodium ions in low domains during pyrolysis.

Researchers have been using the reverse micelle process to prepare carbonate nanowires [3,4]. Also, Kuang et al. [3] observed that $CaCO_3$ nanowire formation occurred by nanoparticle unidirectional aggregation. However, there are no reports in literature on the synthesis of sodium carbonate nanostructures in large scale. In this study, a phenolic-like resin from *Eucalyptus* sp. tar pitch was used as precursor to obtain sodium carbonate nanostructures and a mechanism was proposed.

The sodium-rich resin was prepared by a similar process described by Prauchner et al. [2] in which pitch was heat treated for 4 hours at water reflux temperature in the presence of para-formaldehy as polymerizing agent and NaOH as catalyzer, with different reagent ratios. Na_2CO_3 nanostructures were synthesized in large-scale by pyrolysis of resin at 900 °C in a tubular electric furnace, under a flow of N_2. Aiming to investigate the growth mechanism involved, several experiments were carried out in thermobalance at final temperatures ranging from 100 °C to 650 °C (Fig. 1). The ribbon-like structure behaviour in solvents of different polarities was investigated. The products were characterized by using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), Raman spectroscopy, electron-spray mass spectrometry and atomic force microscopy (AFM).

The high cross-link due to polymerization of the sodium-rich resin induced to microphase separation during pyrolysis that arose domains rich in sodium and surrounded by carbon. These places worked as microreactors for the nucleation of carbonate globular nanoparticles that grow by directional aggregation, and whose driving force seems to be a surface energy anisotropy. When the nanostructures were treated with solvents, these globular nanoparticles self-reorganized and formed different architectures depending on the solvent polarity.

This novel process emerges as a promising strategy for the synthesis of other inorganic nanostructures.

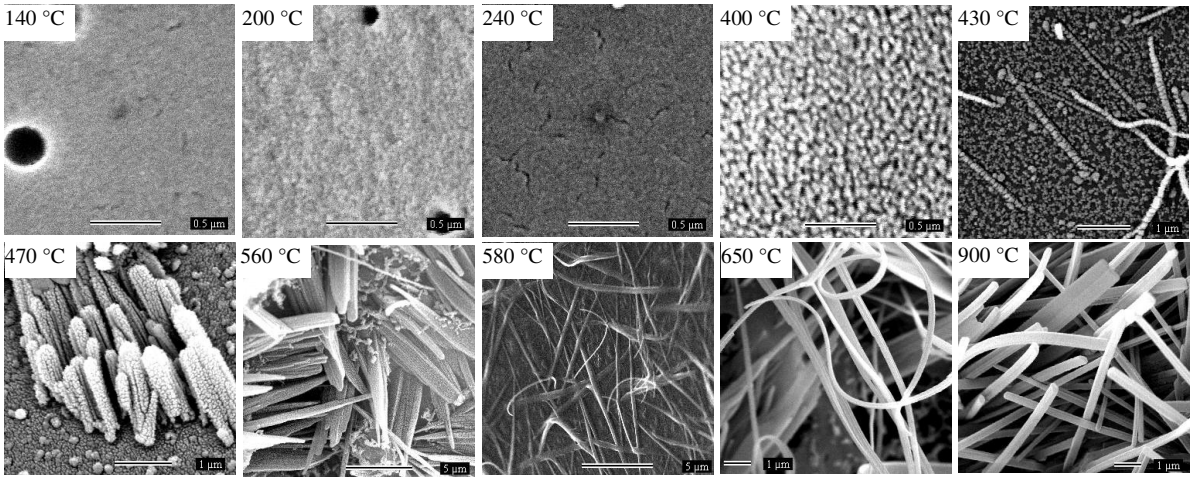

Figure 1: Growth of Na_2CO_3 ribbon-like nanostructure during the heat treatments of sodium-rich pitch in thermobalance

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