XXI Brazilian Meeting on Inorganic Chemistry
X Brazilian Meeting on Rare Earths
III Workshop on Theoretical Bioinorganic Chemistry
Belo Horizonte, September 12 - 15th 2024

Multifunctional aerogels prepared by upcycling of aluminum cans waste

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Thematic Area: Materials Chemistry

Keywords: Aerogel, Sol-gel, Upcycling

Although there is widespread global progress in recycling materials, escalating global consumption and growing waste production emphasize the critical need for creative and sustainable approaches to material reuse and the establishment of a circular economy. For instance, post-consumer aluminum beverage cans represent a crucial category of metal waste, given their widespread global use as a common food packaging material. Although recycling of these cans is a well-established practice, challenges arise from impurities present in diverse aluminum alloys used in can manufacturing, which can complicate complete recycling, making it necessary to add supplementary primary-produced aluminum to adjust impurity concentrations. In light of these challenges, upcycling— the process of transforming waste into higher-value products—emerges as an appealing approach for creating advanced materials from aluminum waste. In the present presentation, we report a facile template-free upcycling approach to prepare Al_2O_3 aerogels from post-consumer aluminum beverage cans and show their multifunctional applications. Direct dissolution of different parts of aluminum cans (body, lid, and bottom) was carried out in a concentrated acid solution. Using epoxide-assisted gelation and supercritical drying, monolithic aluminum oxide hydroxide (boehmite) aerogels were obtained with a white or distinctive reddish color (arising from impurities), depending on which part of the aluminum can was used. Boehmite aerogel crystallization by annealing at different temperatures was studied by XRD, while its porous surface texture and interconnected flake-like nanostructures were revealed by SEM and TEM electron microscopy techniques. N_2 physisorption revealed the high surface area and mesoporous nature of the prepared boehmite and alumina aerogels. ICP-MS analysis was carried out to study presence of metal impurities, which included Mg, Mn and Fe. The prepared aerogels were explored for a myriad of applications, resulting in interesting performances as an electrochemical supercapacitor, photocatalyst supports for water purification, dye adsorbent, and luminescent host matrix for the incorporation of rare-earth ions recycled from spent fluorescent lamps waste. The obtained aerogels, characterized by their unique properties and diverse applications, showcase the potential of upcycling as an attractive avenue for creating advanced materials from waste.

Acknowledgments: CNPq grants 407414/2023-1 and 407747/2022-2

References

[1] D. Raabe et al., Prog. Mater. Sci. 127, 100947 (2022).
[2]K. M. Wyss et al., Nano Today 48, 101781 (2023).