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Improving the H_2O_2 electrogeneration selectivity of biomass-based carbon xerogels through modification with $NaNbO_3$

Nicolas Perciani de Moraes[1,*], Julio César Lourenço[1], Robson da Silva Rocha[2], Liana Alvares Rodrigues[2], Marcos Roberto de Vasconcelos Lanza[1]

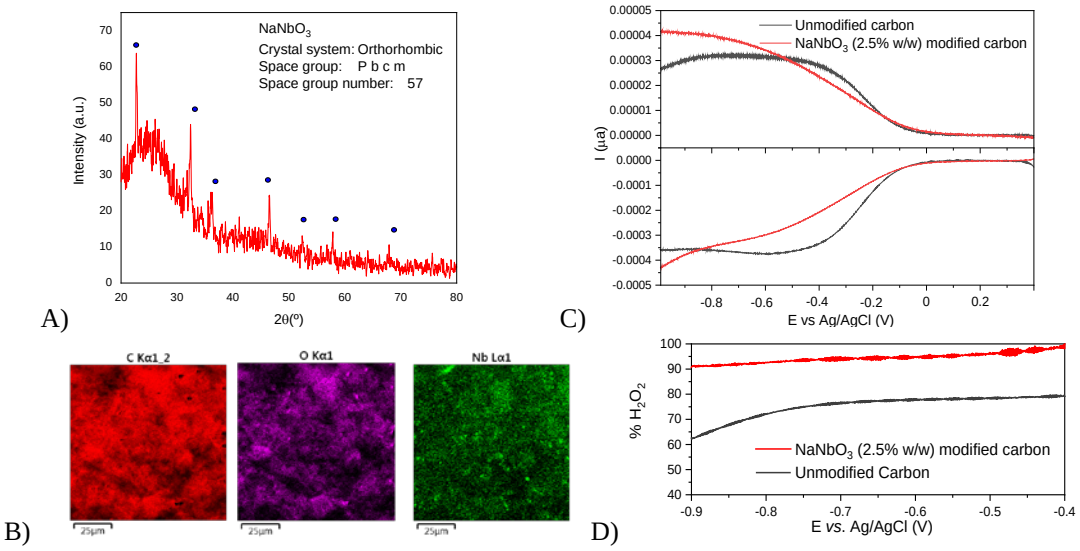
1- University of São Paulo (Chemistry Institute of São Carlos) - Av. Trab. São Carlense, 400 - Parque Arnold Schimidt, São Carlos/SP, 13566-590, Brasil

2- University of São Paulo (Lorena Engineering School) - Estrada do Campinho, 100, Lorena/SP, Brazil

* *nicolas.perciani@usp.br*

Aiming to increase the efficiency of carbon-based electrodes developed for H_2O_2 production, various strategies have been adopted to modify carbonaceous materials. The modification of carbon matrices with semiconductors is a particularly suitable solution to enhance the H_2O_2 selectivity during the electrochemical reduction of oxygen. Focusing on the application of niobium-based semiconductors, potassium niobate has been successfully used to improve the selectivity of H_2O_2 production when supported on carbon blacks (Vulcan XC-72 and Printex L6) [1]. Thus, this work aims to modify cellulose/tannin-derived carbon xerogels with $NaNbO_3$ using a simple one-pot synthesis route. The results show that the proposed modification was successfully achieved, as the orthorhombic $NaNbO_3$ structure was observed in the sample's XRD, as well as in the elemental distribution obtained by EDS. Linear sweep voltammetry analyses (LSV) for the modified material indicate an increase in selectivity toward hydrogen peroxide production and increased ring currents after -0.5 V. Therefore, the distribution of $NaNbO_3$ particles on the carbon xerogel surface probably leads to an efficient electron transfer kinetics for O_2 reduction via the 2-e^- pathway, favoring the formation of H_2O_2. In the study by Antonin et al. (2023), the observed improvement in selectivity is attributed to the O_2 adsorption mechanism on the composite surface. The addition of potassium niobate facilitates the adsorption of *OOH intermediates with an optimal bond distance (O-O = 1.4 Å) and a good charge transfer capacity from the metal atom to the adsorbed oxygen species [1]. Thus, the results obtained in this work further corroborate the application of sodium niobate as a suitable modifier for carbonaceous structures towards higher selectivity in H_2O_2 electrogeneration processes.

Figure 1 – A) XRD of the modified carbon xerogel; B) Elemental mapping of the modified carbon; C) LSV collected for the modified and unmodified materials; D) Selectivity (%) of H_2O_2 formation



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References

[1] Antonin, Vanessa S., et al. "Sodium niobate microcubes decorated with ceria nanorods for hydrogen peroxide electrogeneration: An experimental and theoretical study." *Journal of Alloys and Compounds* 965 (2023): 171363.