Valorization of agro-industrial waste through the extraction of silica for use in catalytic applications involved in CO_2 capture

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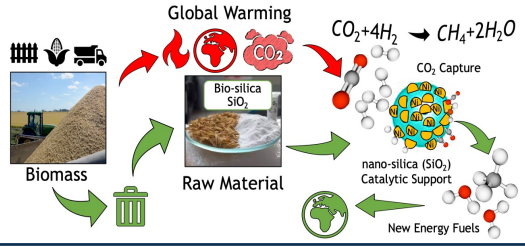
Profile and research skills

I hold a Bachelor's degree in Biology and Chemistry, and a Master's degree in Chemistry from the Universidad de Caldas, Colombia. Currently, I am a Ph.D. fellow at CONICET. I possess extensive knowledge of teaching and learning processes in the natural sciences, chemistry, and biology. I am proficient in developing projects within renowned research groups. My academic background includes a strong focus on chemistry, with substantial experience in writing scientific articles, particularly in analytical environmental chemistry, solid material characterization, biomass utilization, and biotechnological applications. My expertise encompasses the development of analytical methods, extraction techniques (DSASE, SPE, RDSE, SPME, HFMPE), and operation of analytical instruments such as HPLC-DAD-FL-UV, FT-IR, and GC-MS, among others. In recent years, I have expanded my knowledge in data processing and characterization techniques for solid materials such as TEM, SEM, FTIR, XPS, XRD, DLS and BET. I am autonomous, dynamic, versatile and reliable.

Graphical Abstract

This research contributes to green chemistry by reducing the waste load and using renewable resources, thus advancing the goals of sustainable industrial processes. Potential environmental benefits of the project include minimization of agricultural waste and reduction of greenhouse gas emissions, with important implications for the design of sustainable catalysts and CO_2 capture technologies.



Introduction and Results

Nowadays, agro-industrial wastes such as rice husks generate solid waste management problems, due to their difficult degradation and voluminous load for their final disposal [1]. Thus, an interdisciplinary work is being developed to obtain useful raw materials from these wastes [2]. Specifically, rice husk is composed mostly of silica, which can be considered as a renewable natural source of SiO_2 with numerous applications [3]. In this research, a hydrothermal extraction process with sodium hydroxide and sol-gel precipitation was carried out in order to yield high amorphous silica recovery.

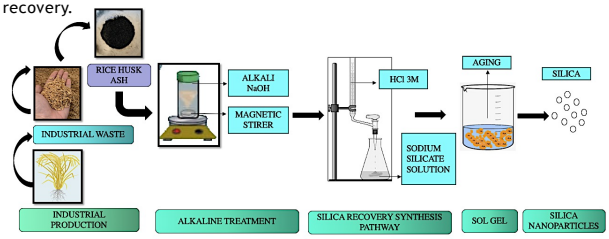


Fig. 1. Simple procedure of chemical treatment process for silica production.

Table 1. Chemical composition of the silicas after being extracted by different treatments.

Sample	Composition metallic %									
	SiO_2	K_2O	CaO	MnO	Al_2O_3	CuO	Fe_2O_3	MgO	ZnO	Cl
TS-550rpm[a]	99.5	0.35	0,06	0.04	0.03	0.01	0.01	0.02	0.07	--
TS-100°C[b]	99.4	0.48	--	0.09	--	0.01	0.02	0.06	0.01	--
TS-40min[c]	99.1	0.71	0.18	0.06	--	0.01	0.03	--	0.01	--

TS: Traditional synthesis method of silica; "—": Not detected
a: [NaOH] 1.0 M; 100° C; 40 min, 550 rpm, 400 µm ash size, pH7

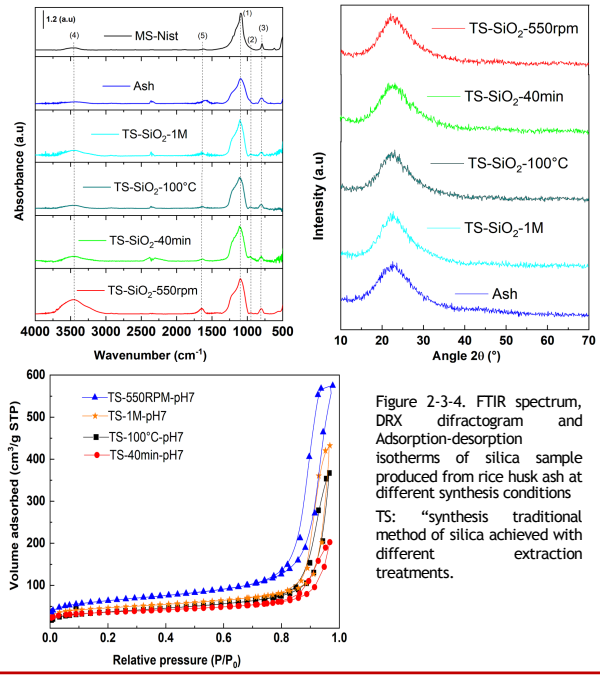


Figure 2-3-4. FTIR spectrum, DRX difractogram and Adsorption-desorption isotherms of silica sample produced from rice husk ash at different synthesis conditions

TS: "synthesis traditional method of silica achieved with different extraction treatments.

Conclusions

- This research represents a significant advance in green chemistry by focusing on accessible synthesis methods, refining extraction processes and developing sustainable chemical practices. The reuse of rice husk ash, an agricultural by-product, helps reduce environmental waste while providing a renewable source of high-purity silica useful in catalytic applications. By employing these catalysts in CO_2 hydrogenation, we open new pathways for greenhouse gas capture, addressing an essential aspect of climate change mitigation. This research not only explores novel ways to manage agricultural waste, but also generates practical benefits for public health and the environment by advancing the capture and use of CO_2.

Acknowledgments

With a clear vision of my role as a change agent, I am eager to apply my skills and knowledge for the benefit of my country and the world. I would like to extend my sincere gratitude to INCAPE, CONICET and the Santa Fe science and technology agency for funding, hosting and providing the space and equipment to develop this research.

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