Área: MAT

Mechanochemical Synthesis of Plasmonic Silver Nanoparticles

Laura L. Lemos (IC),* Ismael P. L. Xavier (PG), Paulo F. M. de Oliveira (PQ).

Laura.liborio@usp.br

Instituto de Química, Universidade de São Paulo

mechanochemistry; silver nanoparticles; nanomaterials; plasmonic catalysis

Highlights

This work investigates the mechanochemical synthesis of AgNPs, offering tunable size and crystallinity for plasmon-enhanced catalysis, though challenges in reproducibility still require optimization.

Resumo/Abstract

Mechanochemical synthesis, such as ball milling, facilitate the efficient, sustainable, and precise synthesis and modification of solid materials. This technique relies on chemical reactions and transformations induced by mechanical force, and has demonstrated success in fabricating diverse functional materials, such as metallic and hybrid compounds, electroactive materials and catalysts [1].

This study investigates the mechanochemical synthesis of plasmonic silver nanoparticles (AgNPs) using hydroquinone -an effective reducing agent for mechanochemical synthesis of metal NPs [2]- and sodium borohydride in over and stoichiometric quantities as reducing agents. Hydroquinone demonstrated superior efficiency, achieving rapid reduction to metallic silver, under 60s when overstoichiometric quantities were used, while sodium borohydride in the same conditions showed limited effectiveness, with less than 25% reduction in 8 hours, contradicting the effectiveness of reducing agents used in solvothermal chemical reductions. HRTEM (High Resolution Transmission Electronic Microscopy) analysis showed AgNPs synthesized with sodium borohydride yielded smaller NPs (~8nm), compared to the synthesis with hydroquinone (~11nm), although all NPs are of spherical morphology. PXRD (Powder X-Ray Diffraction) patterns revealed all NPs to be of face centered cubic structure, and a higher crystallinity was observed for the reducing agent hydroquinone. Preliminary experiments in solid-state plasmonic catalysis, due to silver's LSPR (localized surface plasmon resonance), revealed promising activity, with a 23% reduction of nitroaniline achieved within 2 hours. However, reproducibility and size distribution control remain challenges. These findings highlight the potential of mechanochemical synthesis for producing plasmonic AgNPs with tailored properties, offering a scalable and efficient route for applications in plasmon-enhanced catalysis. Future work will focus on optimizing synthesis conditions and further exploring the catalytic performance of these nanoparticles in various chemical reactions.

Referências/Reference

[1] OLIVEIRA, Paulo Filho Marques. **Challenges and opportunities in the bottom-up mechanochemical synthesis of noble metal nanoparticles**. Journal of Materials Chemistry A, v. 8, p. 16114–16141

[2] XAVIER, ISMAEL P. L. **Mechanochemical hydroquinone regeneration promotes gold salt reduction in sub-stoichiometric conditions of the reducing agent.** Physical Chemistry Chemical Physics, v. 26, n. 15, p. 9-pg., 2024-03-26

Agradecimentos/Acknowledgments

The authors acknowledge FAPESP (2020/14955-6, 2022/03996-9 and 2023/01223-5) and CNPq PIBIC Program for funding.