PÔSTER - RESUMO - MATERIAIS E BIOMATERIAIS

MODULATION OF QUANTUM YIELD IN AU- AND AG-BASED NANOCOMPOSITES BY PULSED LASER-INDUCED CO_2RR

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The growing atmospheric concentration of carbon dioxide (CO2) has fostered the development of sustainable strategies for its conversion into higher value-added chemical inputs [1, 2]. In this context, the CO2 reduction reaction (CO2RR) stands out as a promising approach for the production of gaseous and liquid organic molecules [3]. Although widely studied in electrocatalytic systems [2], direct CO2 fixation in colloidal systems of metal nanoparticles is still largely unexplored. In this work, we investigated CO2 fixation in solid nanomaterials obtained by laser synthesis in liquid media, and colloidal processing of gold and silver (Laser Synthesis and Processing of Colloids – LSPC) in water [4].

We demonstrated that gold nanoparticles synthesized by LSPC exhibit surface species rich in carbon monoxide even when prepared in deionized water. The introduction of CO2 derivatives in an alkaline aqueous medium promotes C2 and C3 coupling reactions, resulting in the formation of carboxylic

acids, a behavior typical of CO2RR. This behavior was observed in both gold and silver targets, showing that the chemical environment during synthesis directly influences the surface composition and functionality of the nanomaterials obtained.

In addition to identifying CO2RR-derived products, we evaluated the impact of these chemical modifications on the optical properties of the systems. We found that pulsed laser-induced CO2 reduction allows the quantum yield (QY) of photoluminescent organometallic nanocomposites (OMNCs) to be modulated. Totally inorganic metal nanoclusters synthesized at the water/argon interface exhibited a QY of around 2% in the visible region. However, the introduction of aqueous CO2 during the process significantly increased the maximum QY to 6% in silver-based systems and 20% in gold-based systems, with emission in the ultraviolet and blue regions of the spectrum.

The results reveal a direct relationship between the reaction environment, the formation of metal-carbonyl species, and photoluminescent performance. It was observed that stable metal-carbonyl species are formed exclusively in gold-based systems, while silver-based nanocomposites did not exhibit analogous behavior, indicating relevant structural and electronic differences between the materials. This distinction suggests that the nature of the metal plays a central role in stabilizing CO2RR intermediates and modulating the final optical properties.

Overall, this study demonstrates that LSPC is a versatile platform for engineering functional nanomaterials, allowing for the integration of CO2 fixation, structural control, and optical property adjustment in a single sustainable synthetic process. The findings contribute to the advancement of carbon conversion strategies and the development of photoluminescent materials with potential applications in optical devices and sustainable technologies.

Reference

[1] Aresta et al., Chem. Rev., 2014, 114, 1709–1742.

[2] Mundada et al., Energy & Fuels, 2025, 39, 17192–17233.

[3] Romero Cuellar et al., J. CO2 Util., 2020, 36, 263–275.

[4] Tahir et al., Small Sci., 2024, 4, 202300328.

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Palavras-chave: laser-assisted colloid synthesis (lspc); pulsed laser-induced co2 reduction reaction; photoluminescent organometallic nanocomposites.