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Synthesis and characterization of carbon dots-Eu^{3+} for volatile organic compounds sensing

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Volatile Organic Compounds (VOCs) are organic compounds with vapor pressures exceeding 0.01 kPa at 293.15 K [1]. Monitoring their emissions is essential to prevent environmental degradation and protect human health. Carbon dots (CDs) have emerged as a promising platform for VOC sensing [2], and with lanthanides like Eu^{3+} an internal calibration in ratiometric sensing is possible, enhancing the accuracy and reliability of VOC detection [3] . With this perspective, this work aims to initially synthesize and characterize CD-Eu^{3+}. The nanoparticle was synthesized using 3 different proportions of CD's precursors with a fixed Eu^{3+} final concentration of 0.015 $mol.L^{-1}$. Citric acid and Urea were used as CD's precursors and $EuCl_3$ for Eu^{3+}. The precursors were solubilized in 50 mL of ethanol within a Teflon liner settled inside a stainless-steel autoclave. This system was closed and heated at 180 °C for 6 h using a muffle furnace. Followed by centrifugation and the precipitate was washed with ethanol several times and dried at 50 ºC overnight. The powder resulting was characterized using powder PXRD, TEM, FTIR and photoluminescence (PL) spectroscopy. By PXRD, a non-crystalline character was observed, with the peak centered at 6.5º and an amorphous halo centering at 24º, indicating possible organic lamellae bridged together. The TEM images indicated the formation of nanoparticles with a size of 5.5 nm but with regions of aggregation. Also, EDS confirmed the Eu^{3+} presence. The FTIR showed a main band associated with carboxylates and aliphatic and aromatic amines. The PL profile of the powder samples indicates the Eu^{3+} coordination with the organic part, possibly to the carboxylate moieties, with a highly asymmetry site. The lifetime results varied from 0.31 to 0.54 ms and the quantum efficiency from 0.08 to 0.14, according to sample compositions. Qualitative experiments with VOCs, embedding the CD-Eu^{3+} in a film derived from sol-gel, resulted in an emission enhanced with NH_3.

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