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Electrosynthesis of chalcogenides and applications on the synthesis of quantum dots, organochalcogenides, and photocatalysis

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Quantum dots (QDs) are nanoscale semiconductor crystals (1-10 nm) that are subjected to strong quantum confinement, presenting unique and size-dependent optical properties, with several applications: development of optoelectronic and photovoltaic devices, metal detection, bioimaging, biomedicine, and more recently photocatalysis. In recent years, the main objective of our research group (Laboratory of Electrosynthesis at UFPE) has been the development of a simple and green method to produce QDs based on cadmium, zinc and bismuth (M) chalcogenides (X) (binary QDs, MX), and indium, silver and copper (N) ternary QDs (AgInX, CuInX). An electrochemical procedure was developed using a cavity cell for the generation of chalcogenides (X = Te^{2-}, Se^{2-} and S^{2-}) in aqueous medium, and absence of reducing agents. Two electrochemical procedures were used: electrolysis at separated anodic compartment, aiming the catodic generation of the chalcogenides; and the paired electrolysis, aiming the simultaneous generation of chalcogenides (X^{2-}) on the cathode, and metal oxidation from a sacrificial anode (M^{2+}). Both methods of synthesis should be carried out in the presence of a stabilizer: cysteamine, mercaptopropionic acid, glutathione, etc. All preparations were carried out in an aqueous medium, allowing the direct application of the QDs in a biological medium. The synthesized QDs were applied in the analytical detection of resveratrol, bioimaging of cancer cells, biomarker for determining the larvicidal activity in Aedes aegypti larvae, fingerprint development, etc. Recently, CdSe nanocrystals stabilized by cysteamine or mercaptopropionic acid have been used as catalysts on the synthesis of sulfones.