Systematic study of parameters in the electrochemical synthesis of magnetite nanoparticles and their implementation in a continuous flow reactor.

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Nano scale magnetite shows a wide array of possible applications, such as: biomedical, environmental remediation and data storage to name a few[1]. The synthesis of magnetite nanoparticles is classically done by coprecipitation of iron salts in an alkaline medium. This methodology usually yields a material with sizes ranging from 5 to 12 nm and require the use of a variety of dispersive agents (surfactants) to control size distribution and aggregation. Electrochemical synthesis on the other hand requires inexpensive iron electrodes and a direct current power source to generate iron hydroxides that evolve to magnetite in an aqueous solution. Sizes obtained by this methodology range from 20 to 30 nm with a narrow distribution, this size range is difficult to accomplish with other methodologies and is especially interesting in biomedical applications[2]. However one of the main setbacks of electrochemical synthesis is the amount of material obtained which varies from 20 to 150 mg per synthesis depending on total current and synthesis time. The goal of this project is to determine the best conditions to synthesize magnetite nanoparticles with high cristallinity and good size distribution, then recreate these conditions in bigger proportion and in a continuous flow electrochemical reactor, in order to increase the amount of material obtained without compromising composition or morphology. Results are promising and show the potential of electrochemical synthesis in large scale production of magnetite nanoparticles. We were able to increase production lineally 8 fold, by increasing the size of electrodes and keeping electrolyte concentration and current density the same. In the process of determining the best experimental conditions, it was found that one of the last steps in the electrochemical synthesis (reduction of iron hydroxide III to magnetite in the cathode) doesn't occur, and magnetite formation actually occurs due to a mechanism similar to that of coprecipitation contrary to previously reported works[1].

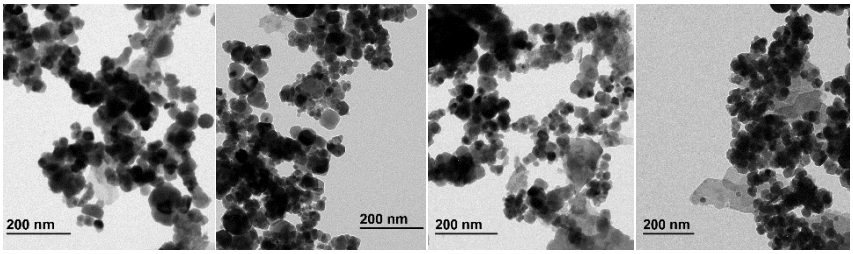

Figure 1. TEM micrographs with increasing anode size: a) 2 cm^2, b) 4 cm^2, c) 8 cm^2 and d)16 cm^2.

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