Synthesis of iron based nanoparticles in presence of nanocellulose for contaminant removal

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Nanocelluloses are natural biopolymers having a diameter in the nano scale. They have recently attracted great research and industrial attention as a multifunctional material to be used in a wide range of applications including packaging, medical and automotive applications, electronics, photonic devices and environmental remediation [1].
Due to their good biodegradability, biocompatibility, non toxicity, porosity, and rich surface in hydroxyl groups, nanocelluloses are promising materials to be used as template for various synthesis reactions [2].
In parallel, iron-based nanoparticles have shown great potential in the last decade for in situ soil remediation and water decontamination. However, the poor chemical stability, mechanical strength and aggregation tendency of iron-based nanoparticles makes it relevant to investigate new approaches to enhance their performance over time [3].
The in-situ synthesis of iron nanoparticles in the presence of nanocellulose is an interesting strategy to generate a biobased composite with enhanced stability and higher contaminant adsorption capacity, due to the additional cellulose functionality. Furthermore, such composite is easy to recover from treated effluents through the action of magnets.
In the present work, the synthesis of iron nanoparticles was carried out in the presence of nanocelluloses with the aim to obtain a novel material for contaminant removal. Since iron salts bind to hydroxyl groups of nanocellulose via electrostatic interaction, this forms oxyhydroxides that act as nucleation points for the growing of iron nanoparticles via reduction. Subsequently, the aggregation of these iron nanoparticles is avoided allowing a better and more homogeneous size distribution (Figure).
Different nanocellulose derivatives and different synthesis conditions were tested. The resulting material was characterized with X-ray photoelectron spectroscopy (XPS), Brunauer–Emmett–Teller analysis (BET), thermogravimetric analysis (TGA), and scanning electron microscopy (SEM). Finally, the decontamination ability of the iron nanoparticles/nanocellulose composite was evaluated and revealed the high efficiency of the novel material.

References

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Figure

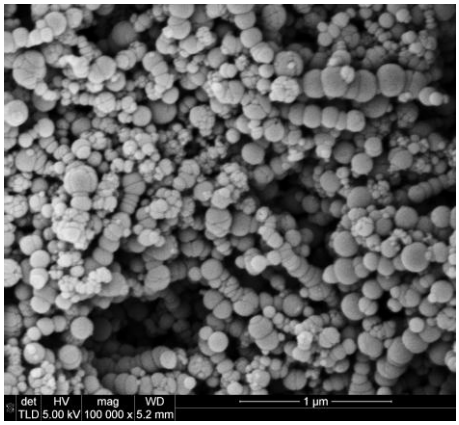

Figure: Iron based nanoparticles synthesized onto nanocelluloses.