# MAGNETITE-BASED NANOSTRUCTURED MATERIALS OBTAINED BY MICROFLUIDIC TECHNIQUES


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**Abstract**


Nanotechnology represents a continuously developing interdisciplinary field, with significant potential in biomedical applications. Among the intensively studied nanomaterials, iron oxide nanoparticles (IONPs) present multifunctional properties, being used as platforms for drug delivery systems and as antimicrobial agents. However, conventional synthesis methods often involve complex processes, high costs, large resource consumption, and reproducibility problems. In this context, microfluidic technology represents a promising alternative, offering more precise control over nanoparticle formation, reduction of reagent consumption, and more reproducible processes.

The present doctoral thesis investigates the use of a three-dimensional microfluidic platform with vortex mixing for the development of innovative antimicrobial nanocomposites based on IONPs. The research was structured in two main directions. The first study aimed at obtaining $Fe_3O_4$ nanoparticles functionalized with salicylic acid and coated with silica, conceived as a nanocomposite system for the controlled release of the antifungal micafungin. The obtained system demonstrated efficient drug loading and a biphasic release profile, indicating the potential for long-term antifungal therapies.

The second study aimed at the development of hybrid $Fe_3O_4$ nanocomposites functionalized with salicylic acid and modified with silver or copper oxide nanoparticles, later integrated into silica aerogels in order to obtain coatings with antimicrobial properties. The nanosystems showed improved biocompatibility, the absence of bioaccumulation in vital organs, and effective antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*.

The obtained results highlight the potential of microfluidic synthesis in the design of advanced antimicrobial nanomaterials with controlled properties and promising applications in the biomedical field.