Obtaining Antimicrobial Textiles through Coordinated Chemistry: Functionalized Textiles from MCM-41 Mesoporous Silica and ZIF-67 Metallic Networks

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Abstract: Textile materials have a natural affinity for microbial species that cause infections due to their proximity to the human body. Therefore, it is essential to consider these microorganisms' adhesion, transfer, and propagation when using textile materials. The search for innovative solutions to promote health and well-being has become a priority, and today, the development of antimicrobial textiles is relevant [1]. Currently, the development of textiles with antimicrobial properties relies heavily on nanotechnology. Some research highlights using silver, zinc, and copper nanoparticles as antimicrobial agents [2]. Mesoporous silica and zeolitic imidazolate framework-67 (ZIF-67) are among the nanoparticles that can be used for functionalization to obtain antimicrobial products. Mesoporous silica is characterized by its nanometric porous structure with a large surface area and high absorption and functionalization capacity with various antimicrobial compounds, which allows their gradual and controlled release [3,4]. ZIF-67 is a metal-organic material with a highly porous crystalline structure, enabling the incorporation of metal ions with antimicrobial properties. Its remarkable stability and adsorption capacity make it an excellent alternative for antimicrobial textile applications [5]. Given this context, the present work aimed to present a study on the characterization and development of antibacterial textiles containing the ZIF-67 metal-organic structure supported on amino-functionalized MCM-41 mesoporous silica nanoparticles. The samples were obtained through a finishing process that involved functionalizing the polyester using the pad-dry-cure method. The material obtained was characterized using analytical techniques, including Fourier Transform Infrared Spectroscopy (FTIR), colorimetric analysis, and antibacterial analysis by adapting the ASTM E2149 standard [6]. A successful deposition of the nanoparticles on the functionalized textile was observed. The antibacterial activity of the textile samples evaluated for the bacteria *E. coli* and *S. aureus* was efficient, following the standard. The evaluation of the durability of the finish represents a relevant aspect for further investigations, considering the potential of functionalization to be applied to hospital clothing, professional uniforms, and household products, promoting effective and safe solutions for protection against microorganisms and contributing significantly to health and security in different areas.

Keywords: *antimicrobial textiles, mesoporous silica, zeolitic imidazolate framework.*

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REFERENCES

[1] Gulati T; Sharma S; Sharma R. K.: Antimicrobial textile: recent developments and functional perspective. Polymer bulletin (Berlin, Germany), v. 79, n. 8, p. 5747–5771, 2022.

[2] Shahidi S; Rashidian M; Dorranian D.: Preparation of antibacterial textile using laser ablation method. Optics & Laser Technology, v. 99, p. 145-153, 2018.

[3] Da Silva L. P: Green nanotechnology for synthesis of metallic nanoparticles. Biotechnology Applied to Agro&Industry, v. 4, 2017.

[4] Santos L. L; Barros S. B. A; Rahim A; Gushikem Y.: In situ synthesis of gold nanoparticles on mesoporous silica surface-functionalized with pyridinium ligands. Journal of Nanoparticle Research, v. 22, p. 1-14, 2020.

[5] Nhavene E. P. F. et al.: Chitosan grafted into mesoporous silica nanoparticles as benznidazol carrier for Chagas diseases treatment. Microporous and Mesoporous Materials, v. 272, p. 265–275, 2018.

[6] ASTM E2149:2020. Standard test method for determining the antimicrobial activity of antimicrobial agents under dynamic contact conditions