

A novel superparamagnetic nanoplatform assisted by light against nonlocal bacterial infections

Reference	Presenter	Authors (Institution)	Abstract
01-182	Martha Simões Ribeiro	Ribeiro, M.S. (Nuclear and Energy Research Institute); Yoshimura, T.M. (Nuclear and Energy Research Institute); Toledo, V.H. (Federal University of São Paulo); Haddad, P.S. (Federal University of São Paulo);	<p>The increasing resistance to antimicrobials worldwide requires new strategies to fight infectious diseases. Antimicrobial photodynamic therapy (APDT) emerges in this scenario as a promising approach. APDT is a light-based therapy combined to a photosensitizer drug and oxygen that kills microorganisms via oxidative stress. Due to its mechanism of action, i.e., generalized oxidation of all cell structures, bacterial resistance to APDT is very improbable. Currently, however, APDT is limited to local treatments. Thus, a platform to deliver the photosensitizer drug in internal organs is urgently necessary. Superparamagnetic iron oxide nanoparticles (SPIONs) can be easily directed to target sites using an external magnetic field, which made them excellent drug delivery systems. In addition, their large surface to volume ratio allows the functionalization of therapeutic molecules on their surface. In this work, we synthesized and characterized SPIONs covered by methylene blue (MB)-entrapped silica (SPIONs-silica-MB) and investigated their potential combined to APDT to kill <i>Escherichia coli</i>, the most common bacteria found in urinary tract infections. We synthesized SPIONs by the co-precipitation of iron (II) and (III) chlorides in the presence of a weak base and covered them with a double layer of silica leading to the hybrid material magnetite-silica-MB. SPIONs were characterized by Fourier transform infrared spectroscopy, powder X-ray diffraction, and magnetic measurements. Kinetics of MB release and production of singlet oxygen from SPION-silica-MB were also obtained. The average crystallite size of magnetite was found to be 14 nm. Infrared spectra showed characteristic bands of iron-oxygen and others associated with silicate groups. At room temperature, the nanoplatform presented magnetic behavior due to the magnetite core. MB release increased exponentially until 18 h, when it reached a plateau. Singlet oxygen was spontaneously released from SPIONs-silica-MB. To verify the photodynamic activity of SPIONs-silica-MB on bacterial cells, 1×10^7 colony forming units of <i>E. coli</i> were suspended in SPIONs-silica-MB PBS solution (50 μM of MB) and were irradiated using a red LED (625 ± 20 nm) of 235 mW over an orbital shaker to prevent precipitation during 5, 10, 15 and 20 min at three different MB release</p>

times: 6, 12 and 22 h. Proper controls were established and showed no killing. In contrast, SPIONs-silica-MB-mediated APDT promoted bacteria inactivation depending on both the time of MB release and irradiation time. Our results show that bacteria are completely eradicated following 22 h of MB release and 20 min of irradiation. These findings motivate the use of SPIONs-silica-MB to mediate APDT against nonlocal infectious diseases.

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