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Preparation, characterization and the antimicrobial properties of metal ion-doped TiO₂ nano-powders

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Abstract: TiO₂ samples doped with lithium, sodium, magnesium, iron or cobalt were prepared by high-energy ball milling for different periods of time. The crystalline phase, chemical composition, crystalline size and photo-absorption were characterized by X-ray diffraction spectroscopy (XRD), X-ray photoelectron spectroscopy (XPS) and Ultraviolet visible diffuse reflectance spectroscopy (UV - Vis - DRS), Fourier transform infrared spectroscopy (FT - IR) and scanning electron microscopy (SEM). The antimicrobial properties of the modified TiO₂ samples were evaluated with *E. coli* and *S. aureus* assays. The results of the XRD show that the TiOSO₄, Ti₃O₅, Li₂TiO₃ and NaTi₂O₄ phases appear along with Li, Na and Mg doped TiO₂. However, XPS spectra indicated that Ti exists as both Ti³⁺ and Ti⁴⁺ in Na-doped TiO₂ samples. Ti³⁺, due to its narrow band gap, is highly active in promoting visible light-induced photocatalytic activity. SEM images showed that the crystalline size of TiO₂ is reduced and has a common-round and hexagonal plate morphology after milling. The modified TiO₂ samples had the best antimicrobial activities after 3 h of milling. In particular, the antimicrobial rate of TiO₂ 5% doped with transition metals (Co, Fe) reached 100% against *E. coli*, but the antibacterial rate against *S. aureus* for Co and Fe dopants was 98.4% and 98.2%, respectively.

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