Haema-Lights: Facile Method of Site-selective Synthesis of Fluorescent Ag-Fe2O3 Nanocomposites for Optical Electron Detection

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Powerful catalysts for the photocatalytic degradation of toxic industrial dyes and effective antimicrobial agents against fungi and bacteria, Ag-Fe2O3 nanocomposites are the subject of much interest. However, hitherto, the chemically intensive, pollutive, hazardous, and expensive synthesis processes of Ag-Fe2O3 nanocomposites stand as a barrier to application. Traditional physical and chemical methods involve the usage of concentrated chemical reducing agents, high temperatures and pressure, producing harmful byproducts, while newer biological methods which use microorganisms as reducing agents present safety challenges. This work first demonstrates a cheap, facile, yet effective method for synthesising Ag-Fe2O3 using a low-cost hotplate method of Fe2O3 nanoflake growth and incorporating Ag via laser modification under AgNO3 solution, without the use of any chemical reducing agents. It is shown that the formation process is precise and composite characteristics like size and uniformity can be easily tuned by varying laser parameters. Morphology and composition characterisation of Scanning Electron Microscopy (SEM), Electron Diffraction X-ray spectroscopy (EDX), Transmission Electron Microscopy (TEM), Raman Spectroscopy, X-ray Photoelectron Spectroscopy (XPS) were conducted and we proposed and verified a potential formation mechanism. Further, the Ag-Fe2O3 nanocomposite has fluorescent properties which respond linearly to electron exposure. An electron-reduction based mechanism was proposed for its fluorescence change and verified based on XPS characterisation and real time observation under the TEM. The sensor is spatially highly precise, easily up to 5 μm. Its micro-scale size and inexpensive synthesis makes it an invaluable complement to existing sensors.