Gold-enhanced visible photocatalysis for antibacterial photodynamic therapy

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Photodynamic and photothermal therapies are gaining attention as antimicrobial strategies. With the aim of developing new hybrid systems with effective activity against localised infections, we here present an experimental study on the photocatalytic properties of nitrogen-doped titanium dioxide (N-TiO_2), a photodynamic agent that, when illuminated, produces reactive oxygen species (ROS), in combination with gold nanoparticles (AuNPs) with well characterised photothermal properties. N-TiO_2 was synthesized as a visible-light photocatalyst and the effect of N-doping on the TiO_2 band-gap was tested using blue light to trigger ROS production. The photocatalytic activity of these materials was assessed by spectroscopy on standard dye, then tested on target biomolecules revealing that DNA was a major target. We mainly focused on the damages induced on the DNA structure, as it is essential for bacteria survival and replication. Critical modifications in DNA structures were observed and were enhanced in the presence of AuNPs as a consequence of the synergetic effect of N-TiO_2 photocatalyst with AuNPs. AuNPs appear to improve the photocatalytic efficiency of N-TiO_2 by stabilizing charge carriers on gold surface then preventing electron–hole pairs recombination. Further studies are ongoing to deepen the observed phenomena and identify key factors effectors of the improved photocatalytic activity.