

# Gold nanorod-assisted photothermal eradication of bacteria

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**INTRODUCTION:** Biomaterials-associated infections (BAIs) pose a serious threat in modern healthcare and constitute considerable limitations to the use of biomaterials. BAIs are generally difficult to manage as they require extended antibiotic treatment and occasionally repeated surgical procedures. One major reason is the formation of a biofilm on the biomaterial surface and the high tolerance to conventional antimicrobial treatments seen. Along with the emerging problem of antimicrobial resistance, the complications related to BAIs make the development of novel ways of preventing or treating these infections of high importance. A possible alternative to conventional antimicrobial treatments for prevention or treatment of BAIs is to photothermally eradicate bacteria using gold nanorods in combination with near-infrared (NIR) light [1]. The NIR light being of clinical relevance as the wavelengths make up the biological window, where light has the greatest tissue penetration. By immobilising gold nanorods on a substrate and irradiating with light corresponding to the nanorods' plasmon resonance frequency, the heat released from the nanorods as the plasmons decay can be utilised to eradicate bacteria growing on the surface.

**METHODS:** Gold nanorods (aspect ratio 3.3) with a maximum longitudinal absorption at 810 nm were synthesised via a wet-chemical, seed-mediated synthesis. The gold nanorods were immobilised on glass substrates via electrostatic self-assembly, and the surface assembly was characterised with scanning electron microscopy and UV-Vis spectroscopy. The antimicrobial activity of the gold nanorod-functionalised glass upon irradiation with NIR light was evaluated by culturing *Staphylococcus Aureus* on the substrates and subsequently irradiating them with a NIR laser (808 nm). Irradiated bare glass substrates and non-irradiated gold nanorod-functionalised glass substrates were used as controls. All the samples were stained with LIVE/DEAD *BacLight* (ThermoFisher) and analysed using fluorescence microscopy.

**RESULTS:** Surface assembly characterisation with SEM showed an even distribution of gold

nanorods over the glass substrates with a surface coverage of 95-100 nanorods/ $\mu\text{m}^2$ . UV-Vis spectroscopy of the substrates revealed that the immobilised gold nanorods maintained their absorbance at 810 nm. In Fig. 1 the average percentage of dead bacteria on the substrates, as determined by image analysis of fluorescence micrographs, is shown. An antimicrobial activity against *S. Aureus* could be observed for the gold nanorod-functionalised glass irradiated with NIR light, which on average exhibited 97 % dead bacterial cells, compared to the 16 % of the irradiated bare glass and 19 % of the non-irradiated gold nanorod-functionalised glass.

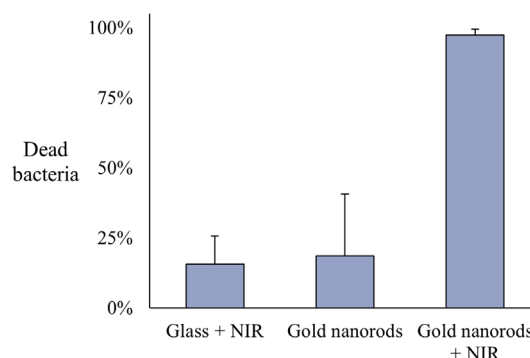


Fig. 1: Antimicrobial activity against *S. Aureus* of gold nanorod-functionalised glass irradiated with NIR light, determined as percentage of dead bacteria through image analysis of fluorescence micrographs. Controls are non-irradiated surfaces and irradiated glass.

**DISCUSSION & CONCLUSIONS:** The initial study shows successful preparation of gold nanorod-functionalised glass substrates that upon exposure to NIR light exhibit antimicrobial activity against *S. Aureus*, demonstrating the potential of using a combination of gold nanorods and NIR light to photothermally prevent and/or treat biomaterials associated infections.

**REFERENCES:** [1] M. Pihl, M. Andersson, "Bacterial biofilm elimination using gold nanorod localised surface plasmon resonance generated heat. Materials Science and Engineering: C, vol. 80, pp. 54-58, 2017.