Multi-Directional Electrodeposited Gold Nanospikes for Antibacterial Surface Applications

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Supplementary Data

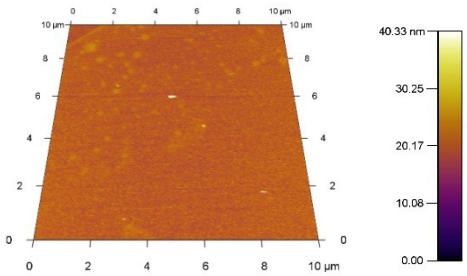

Figure S1. 10 µm × 10 µm AFM image of the unmodified gold surface used as the control for the experiments.

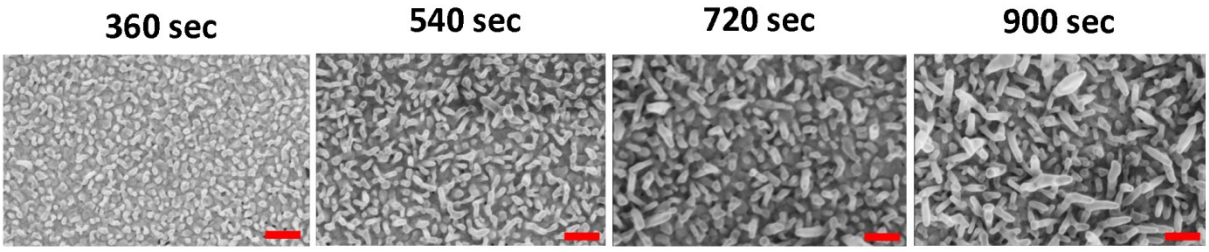

Figure S2. Top-down SEM micrographs of the gold nanospike surfaces as a fucntion of electrodeposition time. The red scale bars represent 500 nm. The concentrations of the precursor materials $HAuCl_4$ and $Pb(CH_3COO)_2$ were 6.8 mM and 1 mM, respectively.

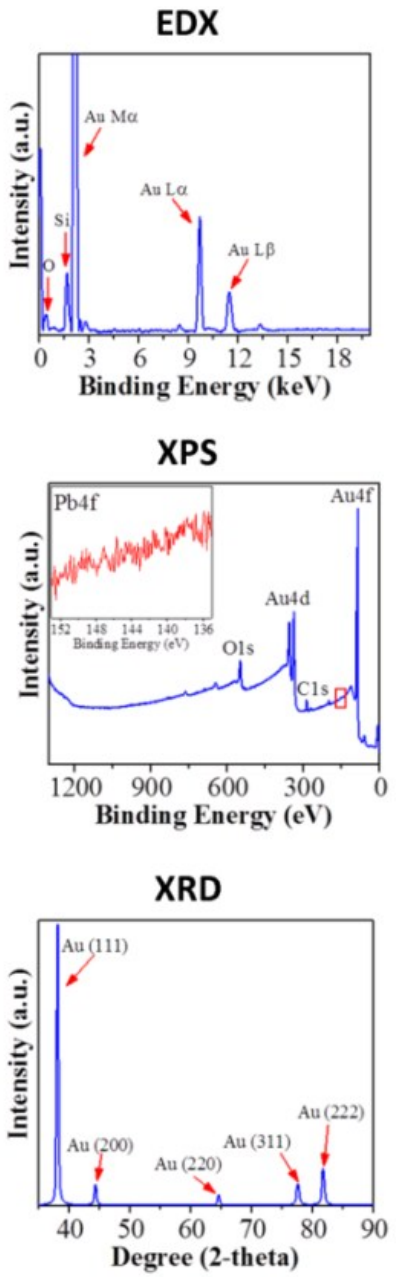

Figure S3. Surface Composition Characterisation. Respresentative EDX, XPS, and XRD spectra of a substratum containing the gold nanospikes following fabrication and washing. Importantly, both Pb^{2+} and Cl^- precursor ions were not observed in the spectra, hence the surfaces were composed of pure gold, which is an inert material.

Figure S3 annotation: One example of the XRD data obtained is shown in Figure S3, which highlights the preferential growth taking place along the Au(200) plane. Here, energy-dispersive X-ray (EDX) and X-ray photoelectron spectroscopy (XPS) were used to confirm that no Pb^{2+} or Cl^- ions were present on the electrodeposited surfaces following fabrication (see Figure S3). Had these ions been present, characteristic Pb peaks would have been seen at ~ Lα = 10.551 keV and ~ 138.4 eV and characteristic Cl peaks would have been seen at ~ Kα =2.622 keV and ~200 eV in the EDX and XPS spectra, respectively. The absence of such peaks corroborates the recent work on similar systems, which revealed that unwanted precursor ions were not present in the post-fabricated nanospikes.[1-3] Most importantly, the XRD, XPS, and EDX data revealed that the surface deposited gold was pure, and hence any antibacterial activity taking place upon contact with these surfaces was a result of physical interactions between the bacteria and the surface.

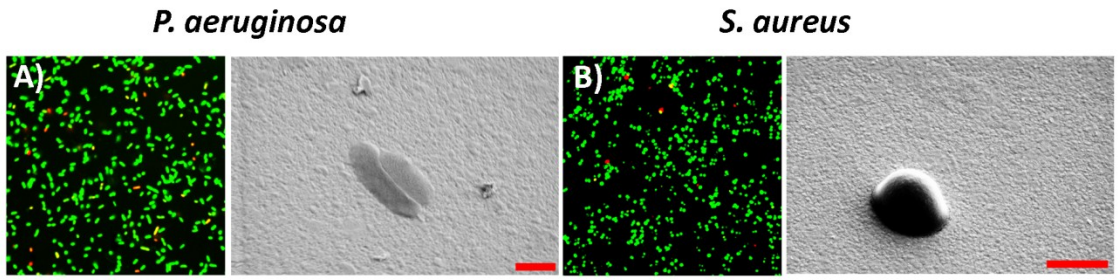

Figure S4. Representative 70 µm × 70 µm CLSM and SEM micrographs of the substrate surfaces. These systems were used as the control for the experiments. The red scale bar in the SEM images represents 1 µm.

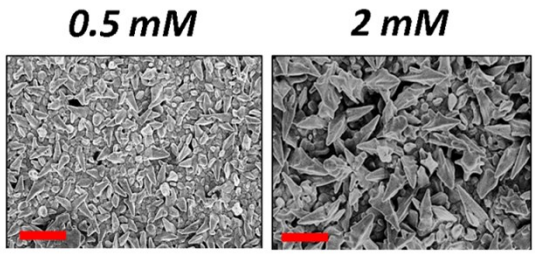

Figure S5. Top-down SEM micrographs of the $Pb(CH_3COO)_2$ precursor concentration series. The red scale bar represents 1 µm.

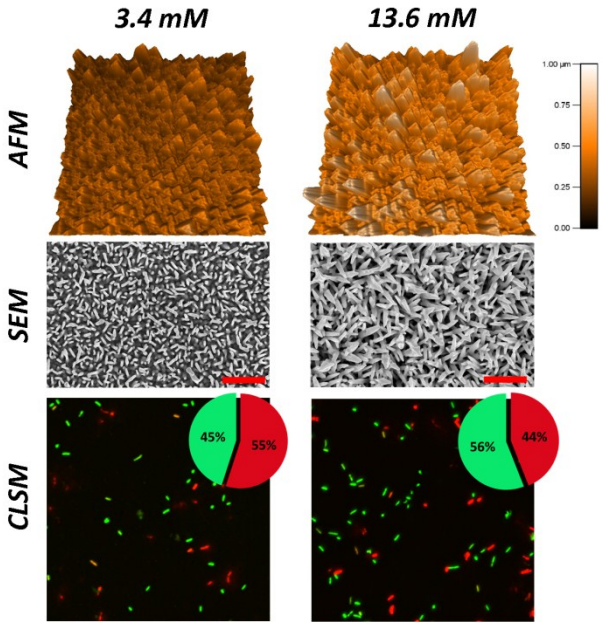

Figure S6. Native surface data for the $HAuCl_4$ concentration series. Row 1) 5 µm × 5 µm AFM images of the resultant gold nanospike surfaces . **Row 2)** Top-down SEM images. **Row 3)** Cell viability of *P. aeruginosa* (ATCC 9721) cells against the surfaces shown in Row 1 as a function of precursor $HAuCl_4$ concentration. Fluorescent staining of the samples with LIVE/DEAD Backlight highlights the live (green) cells and dead (red) in the CLSM images. The corresponding average non-viable cell count (red cells) is shown as pie charts. The CLSM image size is 70 µm × 70 µm.

Table S1. Surface characteristics of the gold nanospikes as a function of precursor $HAuCl_4$ concentration. The $Pb(CH_3COO)_2$ remained constant at 1 mM.

	3.4 mM	6.8 mM	13.6 mM
Spacing (nm)	203 ± 89	211 ± 120	261 ± 182
Height (nm)	100 ± 52	302 ± 57	178 ± 82
Cap Radius (nm)	58 ± 20	60 ± 13	72 ± 62
Density (/µm²)	18.24	16.04	13.80
Surface Roughness (Ra)(nm)	46.8	93.0	70.6

References

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3. Coyle Victoria, E., Kandjani Ahmad, E., Sabri Ylias, M. & Bhargava Suresh, K. Au Nanospikes as a Non-enzymatic Glucose Sensor: Exploring Morphological Changes with the Elaborated Chronoamperometric Method. *Electroanalysis* **29**, 294-304 (2016).