## **Supplementary Information**

## S.I.1 Metal analysis of the modified material

The metal concentration present in the nanocomposite material was determinate by an Induced Coupled Plasma Atomic Emission Spectrometry (ICP–AES) using an Iris Intrepid II XSP spectrometer (Thermo Electron Co.) or coupled with a Mass Spectroscopy (MS) detector (ICP-MS Agilent 7500). In both cases, material samples were treated with 1 mL of concentrated nitric acid to oxide the metals and the mixture was diluted 25 times to be analyzed. Before the sample measurement, the ICP signals corresponding to each metal were calibrated with certified standard solutions (JT Baker). The wavelengths that showed better sensitivity without interference were chosen. The instrumental average uncertainty of metal ions determination was in all cases lower than 2%.

# S.I.2. SEM and TEM imaging

To obtain the metal concentration profiles along the cross-section of the NC, Scanning Electron Microscope (SEM) coupled with Energy-Dispersive Spectrometer (EDS) (both JEOL JSM 3600, Jeol Ltd. And Zeiss EVO MA 10) was used. The size and the morphology of the NPs were obtained by Transmission Electron Microscope (TEM, JEOL 2011, Jeol Ltd.). Prior to the microscopic examination, samples were embedded in an epoxy resin and cross-sectioned with a Leica EM UC6 Ultramicrotome using a 35° diamond knife (Diatome).

# S.I.3. SQUID measurement

Superconducting Quantum Interference Device (SQUID), from Institut de Ciències dels Materials from Barcelona (CSIC), was used to determinate the magnetic properties of the developed polymer-metal nanocomposites. In few words, SQUID is a very sensitive magnetometer used to measure extremely weak magnetic fields, based on superconducting loops containing Josephson junctions. In our case, an SQUID MPMS-XL7 was used at 300 K within a working range of the magnetic field intensity from 0 to 7 T. Fibre samples of 5 mg were accurately introduced in suitable test tubs and the magnetization was analyzed.

## S.I.4. Cytotoxicity assays

Determination of cell viability is a common method to estimate biocompatibility of biomaterials. The cytotoxicity of the materials was evaluated in vascular smooth muscle cells (VSMCs) cultured from rat aorta by using the colorimetric MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) assay. This technique is based on the ability of viable cells to transform the MTT salt into formazan dyes. VSMCs were tripsinised and plated at  $7 \cdot 10^4$  cell/well in a 96-well culture plate containing Dulbecco's Modified Eagle's medium (DMEM) (Gibco-Invitrogen, Spain) and were maintained for 24 h to attach. After a 24 h incubation period with the raw material and the material containing Fe<sub>3</sub>O<sub>4</sub>-NPs (1, 5 and 10 beads), the medium containing the samples was aspirated, the wells were washed with phosphate buffered solution and the MTT solution (1 mg/mL) was added and incubated for 4 h. The purple formazan generated by viable cells was solubilized with 20% sodium dodecyl sulphate in 0.02 M HCl and incubated for 10 h at 37°C. The optical density of each well was determined at 540 nm in a microplate spectrophotometer reader. Cell viability was expressed as percentage in relation to controls (non-treated cells).



**Figure S.I.4.1.** Representation of the variation of the percentage of cell viability with the number of beads under test.

#### S.I.5. Antibacterial tests

For the antibacterial tests, *Escherichia coli* (*E. coli*, CGSC 5073 K12) and *Pseudomona putida* (*P. putida*, KT2442) cultures were provided by the Department of Genetics and Microbiology of the Universitat Autònoma de Barcelona (UAB). *Luria-Bertani* (*LB*) and Ringer media were used for the bactericide activity tests. Two tests were performed to evaluate the antibacterial activity of the nanocomposite: the minimum inhibitory concentration (MIC) test and continuous flow analysis. Both analyses are detailed below.

#### S.I.5.1. Minimum Inhibitory Concentration (MIC) test

The MIC is defined as the concentration of an antimicrobial agent that completely inhibits the microorganisms' proliferation in the sample. In this case, the MIC of each material was determined by introducing an increasing amount of nanocomposite in individual wells of a 96-well ELISA plate already containing 200  $\mu$ L of 10<sup>5</sup> Colony Forming Units per mL (CFU/mL) of *E. coli* suspension in LB medium. After overnight incubation (16 h), bacterial proliferation was evaluated by measuring the optical density of each well at 550 nm using a SmartSpec<sup>T M</sup> Plus Spectophotometer (Biorad). The inhibitory activity of the Ag, Fe<sub>3</sub>O<sub>4</sub> and Ag@Fe<sub>3</sub>O<sub>4</sub> nanocomposites was determined. The raw material (A520E) was used as control. Previously, all the nanocomposites beads were sieved at 500 µm of beads diameter.

#### S.I.5.2. Continuous flow analysis

The bactericide activity of the nanocomposite was also evaluated under fluidic conditions. Experimentally, 0.4 g of nanocomposite were introduced in an ion exchange column (0.5 cm diameter, 3 cm length). The column was connected to a peristaltic pump that allowed the control of the flow rate. Bacterial samples containing  $10^4$  CFU/mL of *P. putida* in AB Minimal Medium (ABMM) were forced to pass through the column at a flow rate of 1 mL/min. The experimental set-up is illustrated below.



**Figure S.I.5.2.1.** Representation of the experimental setup for the recirculation of contaminated solutions through the NC for a long-term experiment. 1. Fresh media (ABMM+glucose) 2. Substrate reactor, 3. columns containing raw/NPs modified polymers beads, 4. Diluted contaminated substrate media. Cell concentration in the reactor=  $10^6$  CFU/mL, D (dilution rate) of 0.25.

Filtrate aliquots were regularly extracted and either cultured on agar plates containing LB or analyzed using ICP-AES as indicated in S.I.1. Bacteria concentration was determined by counting the number of colonies after overnight incubation at 37°C.

# S.I.5.3. Confocal laser scanning microscopy (CLSM) imaging

CLSM was used to study the composition of the bacterial structure attached on the NC structure. It is well-known that bacteria can attach to solid surfaces creating complex structures containing cells, exopolysaccharides and other compounds called biofilms. After 10 days of incubation in  $10^4$  CFU mL<sup>-1</sup> *P. putida* suspensions, NC samples were fixed with 2.5% glutaraldehyde in 0.15 M PBS. pH 7.0, for 1.5 h. After washing with PBS, bacteria were stained with DRAQ5 (red fluorescence) and the extracellular polysaccharide was stained with fluorescein isothiocyanate-concanavalin A (FITC-ConA;  $50\mu$ g/ml) (green fluorescence) or WGA (red fluorescence) for 30 min. CLSM images were obtained with a Laser Confocal Leica TCS SP2 AOBS (Leica, Heidelberg, Germany).

Figure S.I.5.3.1 shows the exopolysaccharide and bacteria accumulation (biofilm formation) on the Ag-NC after 10 days of incubation.



**Figure S.I.5.3.1.** CLSM images of the surface (left) and the cross-section (right) of Ag-A520E NCs after being 10 days of incubation in *P. putida* cultures. Blue fluorescence = NC autofluorescence, red fluorescence = exopolysaccharides and bacterial cells, green fluorescence = exopolysaccharides.