

Supporting Information

Antimicrobial graphene polymer (PVK-GO) nanocomposite films

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Experimental

Preparation of the electropolymerized PVK-GO film.

The preparation of the antimicrobial PVK-GO (97:3 PVK-GO wt %) film was similar to previously reported literature [1]. Briefly, the polymerizing solution was prepared by mixing 0.1 M TBAH (2 mL) in acetonitrile with PVK-GO (50 μ L) at 97:3 (wt %) ratio. The PVK-GO film was deposited on bare ITO by repeatedly scanning the potential between 0 to 1500 mV at a scan rate of 10 mV/s for 50 cycles. Ag and Pt wires were used as the reference and counter electrode, respectively. The deposited film was washed with acetonitrile (3x) to remove any unbound material from the surface.

Surface Characterizations:

Atomic Force Microscopy: The morphology before and after electropolymerization of PVK/GO on ITO glass substrates were characterized by AFM. Atomic force microscopy (AFM) imaging was done under ambient conditions with a PicoSPM II (PicoPlus, Molecular Imaging - Agilent Technologies) in the Magnetic AC mode (MAC mode) using a magnetic field to drive a magnetically coated cantilever in the top-down configuration. Type II MAC levers with a spring constant of 2.8 nN/M with about 10 nm tip radius were used for all scans.

Attenuated Total Reflectance Fourier Transformed Infrared (ATR FTIR): The ATR FTIR spectra were obtained on a Digilab FTS 7000 equipped with a HgCdTe detector from 4000 to 600 (cm^{-1}) wavenumbers. All spectra were taken with a nominal spectral resolution of 4 cm^{-1} in absorbance mode. All films were measured under ambient and dry conditions for several trials at different areas of the sample surface.

X-ray photoelectron spectroscopy (XPS) measurements: XPS measurements of the samples were performed using a PHI 5700 X-ray photoelectron spectrometer (XPS), which was equipped with a

monochromatic Al K α X-ray source ($h\nu = 1486.7$ eV) incident at 90° relative to the axis of a hemispherical energy analyzer. The spectrometer was operated both at high and low resolutions with pass energies of 23.5 and 187.85 eV, respectively, a photoelectron take off angle of 45° from the surface, and an analyzer spot diameter of 1.1 mm. High-resolution spectra were obtained for photoelectrons emitted from C 1s and N 1s. All spectra were collected at room temperature with a base pressure of 1×10^{-8} torr. Electron binding energies were calibrated with respect to the C1s line at 284.8 eV. A PHI Multipak software (ver 5.0A) was used for all data processing. The high-resolution data was first analyzed by background subtraction using the Shirley routine and a subsequent nonlinear fitting to mixed Gaussian-Lorentzian functions. Atomic compositions were derived from the high-resolution scans. Peak areas were obtained after subtraction of the integrated baseline and corrected for sensitivity factors.

Antibacterial Measurements:

Bacterial Culture: A single isolated *Escherichia coli* K12 MG1655 (*E. coli*) colony was inoculated in 5 mL Tryptic Soy Broth (TSB) overnight at 35°C . The bacterial culture was centrifuged at 3000 rpm for 10 minutes, and the bacteria pellet was resuspended in TSB. The optical density of the suspension was adjusted to 0.5 at 600 nm, which corresponds to a concentration of 10^7 colony forming units per milliliters (CFU/ml).

Treatment of samples with bacterial culture: Aliquots of 180 μl of bacterial suspensions (10^7 CFU/ml) were placed in an Eppendorf tube containing 20 μl of sample (GO, GO-PVK, PVK) of 1000 $\mu\text{g/ml}$ concentration in DI water. Control samples contained 180 μl of bacterial suspensions added with 20 μl of DI water. The tubes were shaken at 50 rpm for 1h at room temperature.

Antimicrobial Activity determined by growth curve measurements: The antimicrobial property of GO, GO-PVK, and PVK samples were evaluated by examining the bacterial growth curves via OD₆₀₀ after 1 h exposure to these materials [2]. Briefly, the mixtures of bacteria and samples were transferred into 5 mL TSB broth, and incubated at 37 °C. Bacterial growth was monitored by measuring the OD₆₀₀ every hour using Spectrophotometer (Perkin Elmer). The OD curves were generated by plotting the OD values versus growth time. The fast or slow increase in OD during the incubation represents the ability of *E.coli* to survive and grow in the presence of the different nanomaterials.

Antibacterial measurements on stainless steel substrates: PVK-GO, PVK, GO-modified films and unmodified ITO substrate were individually placed in a 12 well-plate (Falcon). To each well was added 1.0 ml of bacterial culture and then incubated at 37 °C (without shaking) for 2 h. The samples were then removed and, immediately prior to viewing, were stained with 3ml of L 7007 Live-dead stain solution for 10 minutes from Molecular Probes (Leiden, The netherlands) containing a green fluorescent dye (Syto 9) marking viable bacterial cells and red fluorescence dye (PI) for detection of dead cells. The surfaces were placed in microscope slides, covered with a cover slip and imaged using BX 51 Olympus Fluorescent Microscope equipped with a DP72 digital camera under 100x objective. All images were acquired and analyzed using cell Sens Dimension software (Olympus). Percent dead was expressed as the percent of the ratio of the total number of dead cells to the total number of bacteria attached.

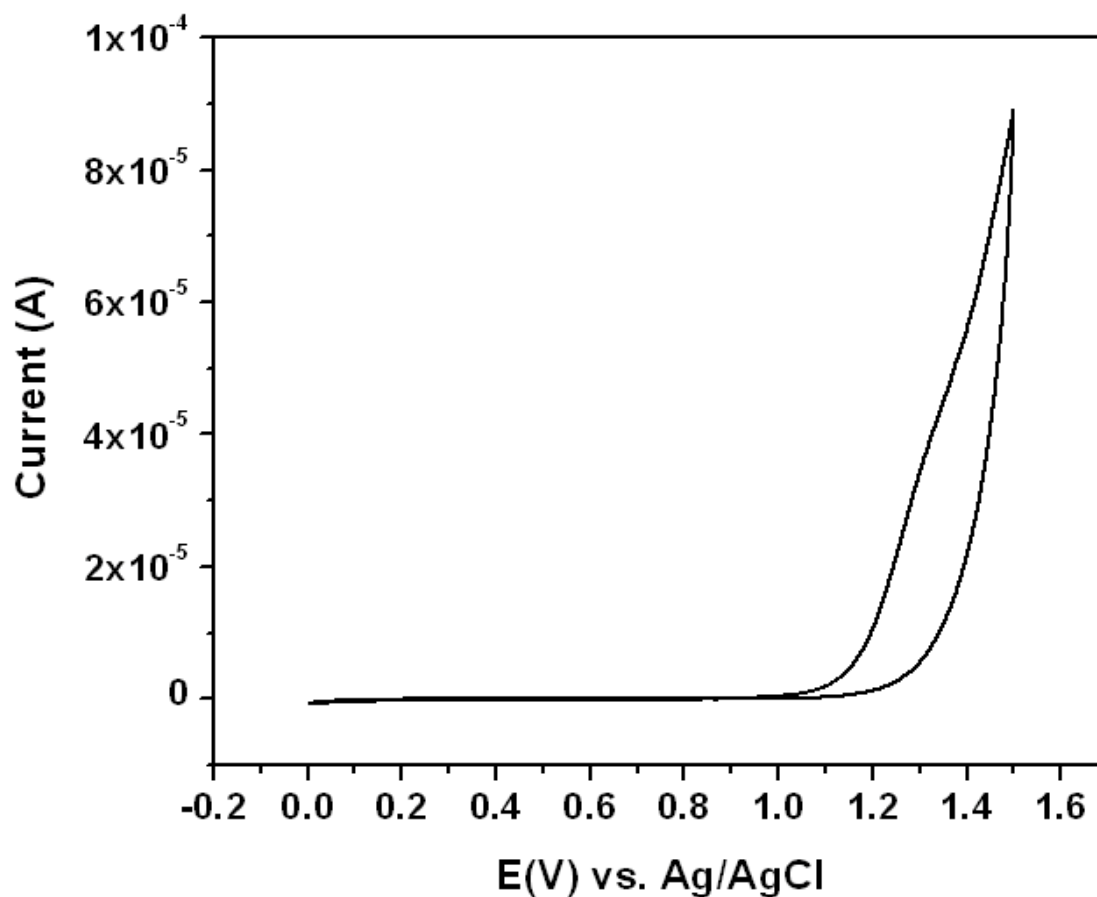


Fig. S1. Monomer-free scan of the electrodeposited PVK-GO film on ITO using TBAH/acetonitrile

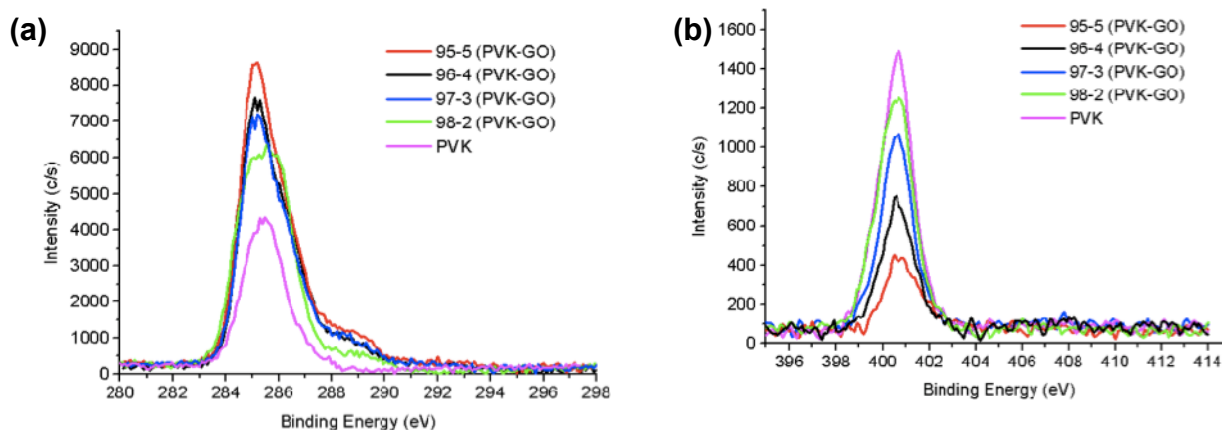


Fig S2. XPS narrow scans of the electrodeposited PVK-GO films on ITO. (a) C 1s (b) N 1s regions.

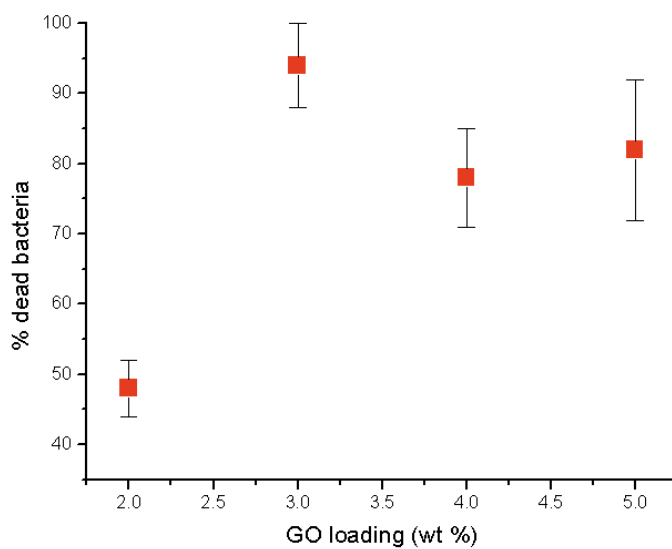


Fig S3. Correlation between GO loading on the bacterial toxicity of PVK-GO films against *E. coli*.

References:

- [1] R. C. Advincula, R. A. M. V. Vergara, K. M. Cui, C. M. Santos, M. C. R. Tria, *J. Mater. Chem.* 2011, submitted.
- [2] C. Yang, J. Mamouni, Y. Tang, L. Yang, *Langmuir*, **2010**, *26*, 16013.