Supplementary material

Innovative dual-contrast nanocoating for central venous catheters: Prolonged infection resistance and enhanced imaging

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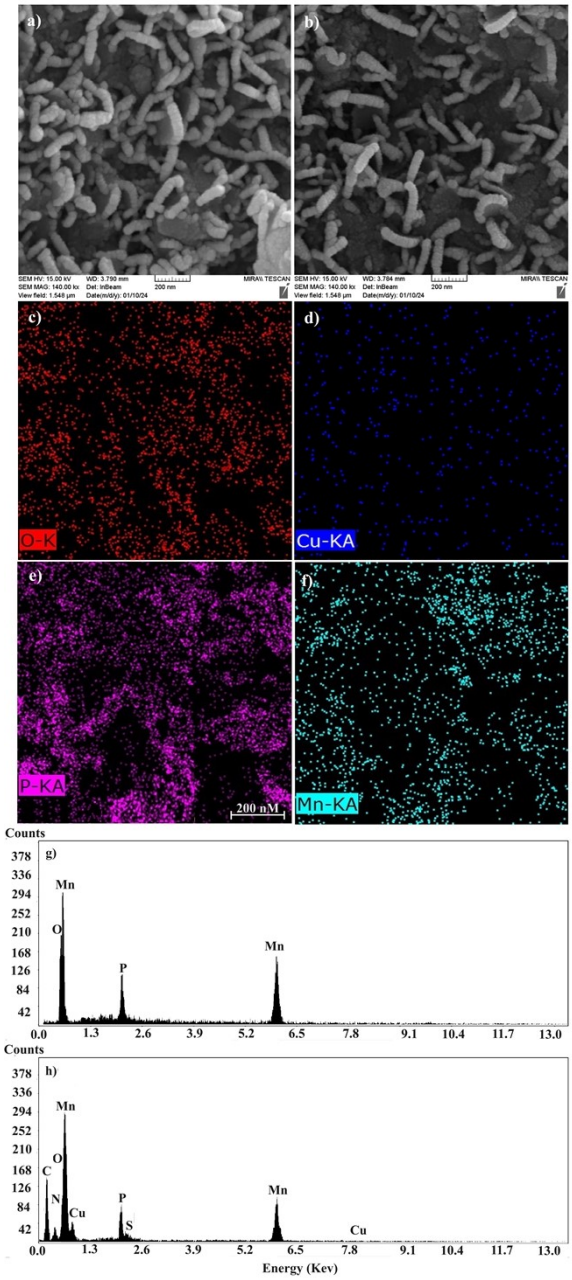

Figure S1. Scanning electron microscope (SEM) imaging of (a) $Mn_3(PO_4)_2$•NSs and (b) laccase@$Mn_3(PO_4)_2$•HNSs; Energy dispersive X-ray analysis (EDX) mapping of (c) oxygen, (d) copper, (e) phosphor, and (f) manganese for a cross-section of the prepared laccase@$Mn_3(PO_4)_2$•HNSs; EDX spectra of the synthesized (g) $Mn_3(PO_4)_2$•NSs and (h) laccase@$Mn_3(PO_4)_2$•HNSs. The immobilization was performed in phosphate buffer (100 mM, pH 7.5) containing laccase activity of 0.8 U mL^{-1} at 25 °C.

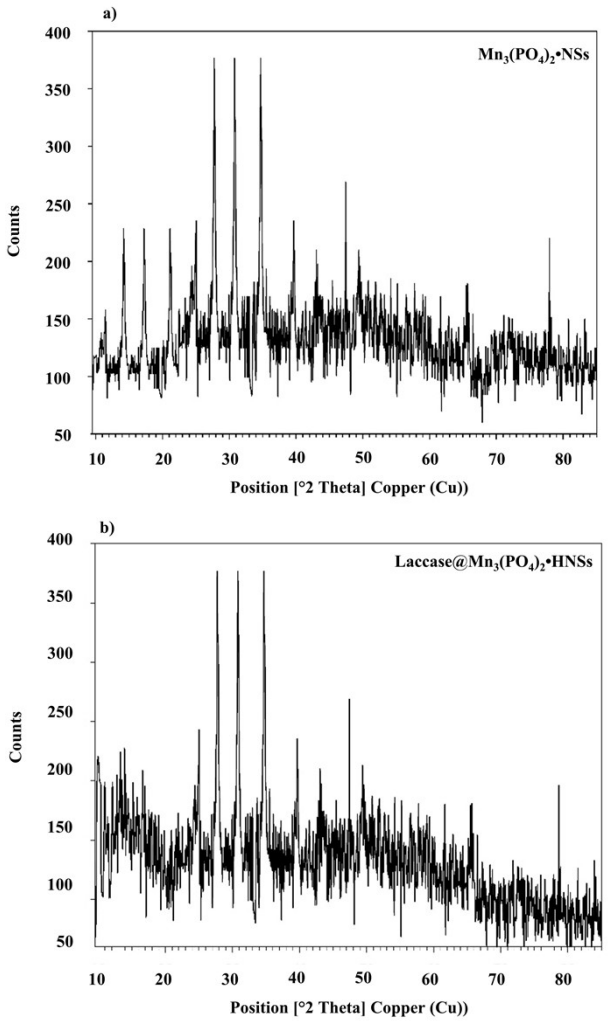

Figure S2. X-ray diffraction analysis (XRD) of the constructed (a) $Mn_3(PO_4)_2$•NSs and (b) laccase@$Mn_3(PO_4)_2$•HNSs, respectively.

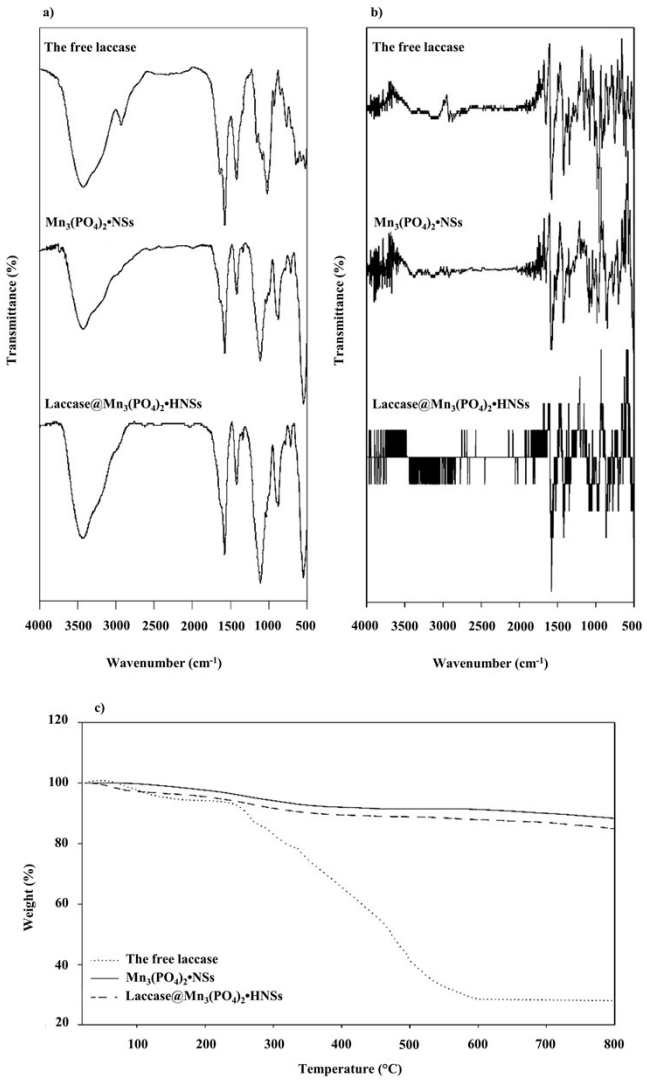

Figure S3. (a) Fourier-transform infrared spectroscopy (FTIR), (b) the first derivative spectra, and (c) Thermogravimetric analysis (TGA) curves of the free laccase, $Mn_3(PO_4)_2$•NSs, and laccase@$Mn_3(PO_4)_2$•HNSs. For TGA analysis, the temperature increased at 10 °C min^{-1} from 150 to 800 °C.

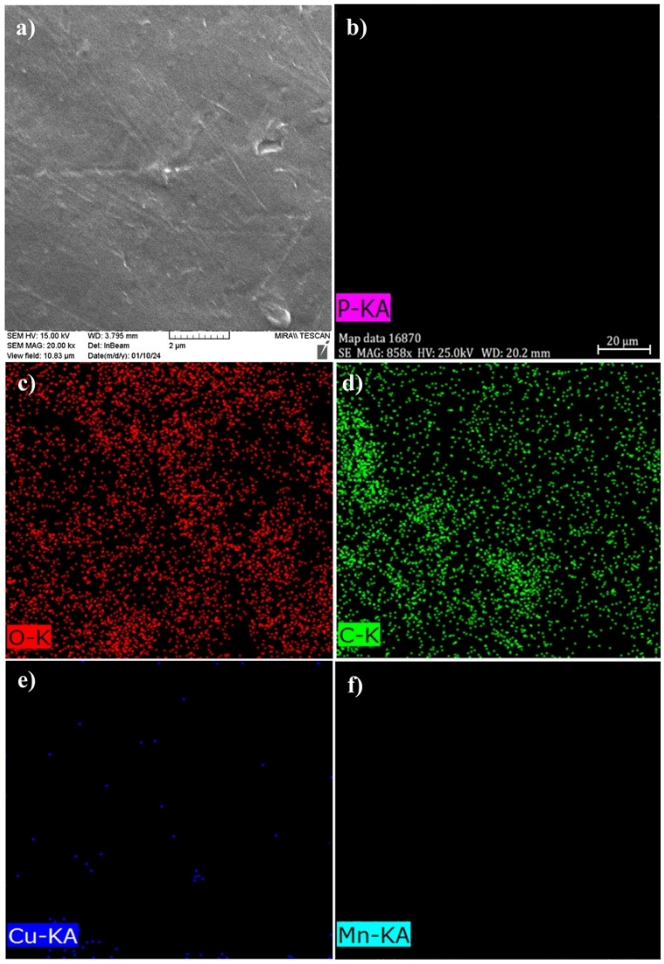

Figure S4. Scanning electron microscope (SEM) imaging of (a) the bare central venous catheters (CVCs); Energy dispersive X-ray analysis (EDX) mapping of (b) phosphor, (c) oxygen, (d) carbon, (e) copper, and (f) manganese for a cross-section of the bare CVC.

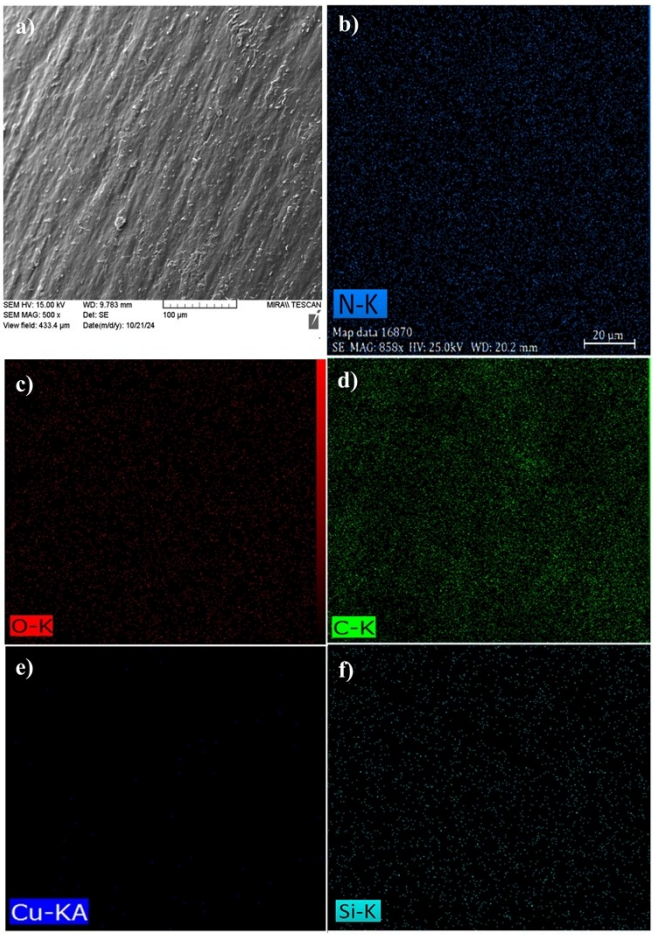

Figure S5. Scanning electron microscope (SEM) imaging of (a) the APTES-modified central venous catheters (CVCs); Energy dispersive X-ray analysis (EDX) mapping of (b) nitrogen, (c) oxygen, (d) carbon, (e) copper, and (f) silicon for a cross-section of this sample.

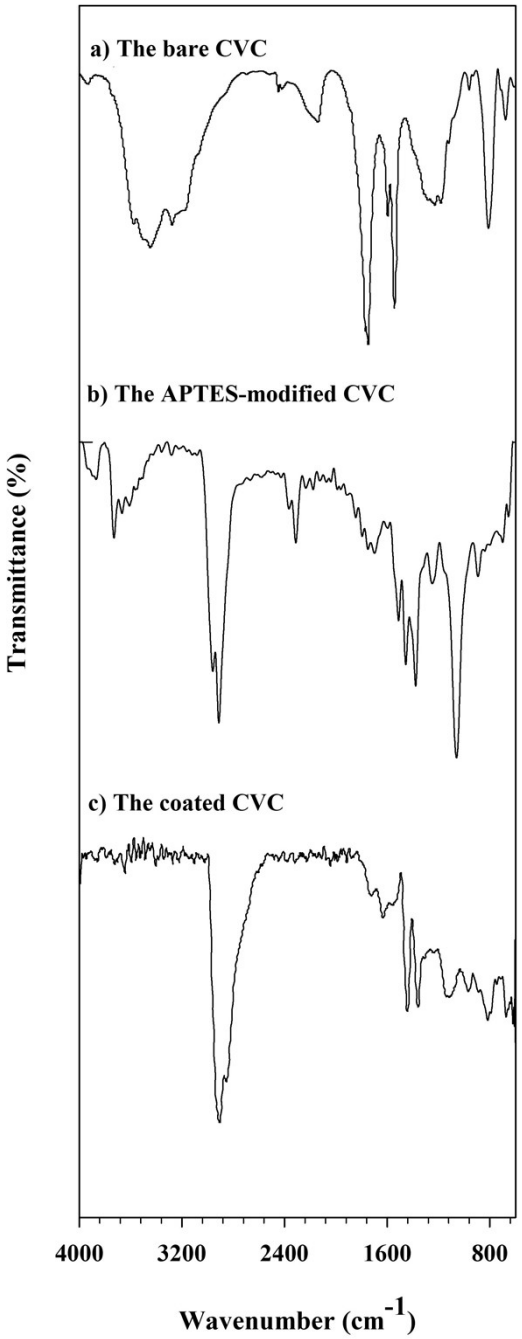

Figure S6. Fourier-transform infrared spectroscopy (FTIR) of the bare, APTES-modified, and laccase@$Mn_3(PO_4)_2$•HNSs/gallic acid-coated central venous catheters (CVCs).

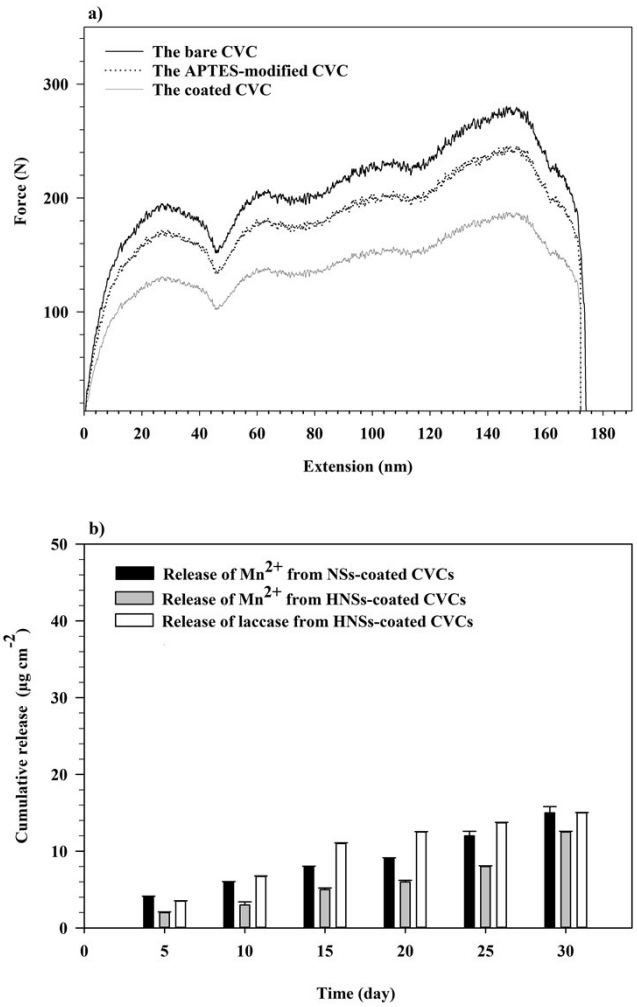

Figure S7. The tensile stress of the virgin, APTES-modified, and laccase@$Mn_3(PO_4)_2$•HNSs/gallic acid-coated central venous catheters (CVCs). The cumulative release of Mn^{2+} and laccase from the $Mn_3(PO_4)_2$•NSs and laccase@$Mn_3(PO_4)_2$•HNSs coated CVC under mild shaking at 37 °C for 30 days.

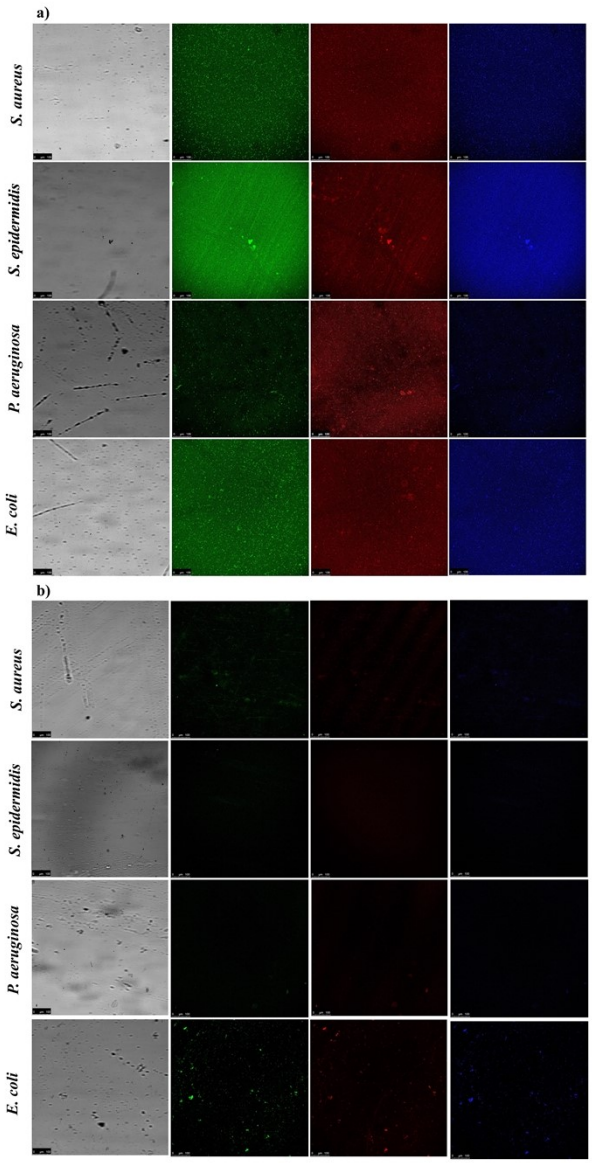

Figure S8. Fluorescence microscopic analysis of *Staphylococcus aureus* (*S. aureus*), *Staphylococcus epidermidis* (*S. epidermidis*), *Pseudomonas aeruginosa* (*P. aeruginosa*), and *Escherichia coli* (*E. coli*) biofilms formed after 24 h incubation with (a) the uncoated and (b) laccase@$Mn_3(PO_4)_2$•HNSs/gallic acid-coated central venous catheters (CVCs). Bacteria were stained with ConA-FITC (green), FM11-43FX (red), and DAPI (blue) for the detection of exopolysaccharide (EPS) residues, bacterial membranes, and nucleic acids, respectively. The scale bar of the picture is 100 μm.

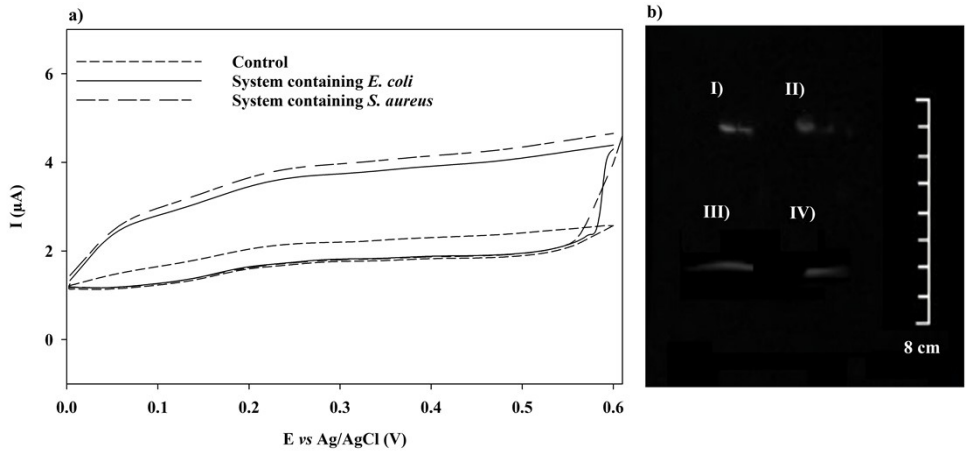

Figure S9. (a) Cyclic voltammetry (CV) spectrum of modified electrons with laccase@$Mn_3(PO_4)_2$•HNSs to assess redox activity and bacterial cell wall penetration potential. (b) Comparison of computerized tomography (CT) values and magnetic resonance imaging (MRI) between the HNSs-coated CVCs (I) (III) before and after (II) (IV) 15 days of implantation.