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Core–Shell-Heterostructured Magnetic–Plasmonic Nanoassemblies with Highly Retained Magnetic–Plasmonic Activities for Ultrasensitive Bioanalysis in Complex Matrix

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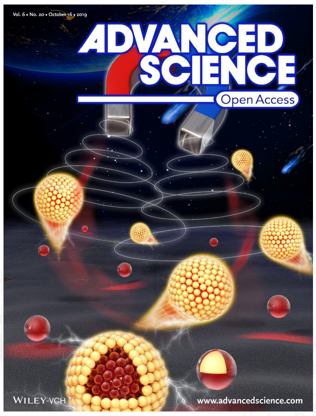
Introduction

Magnetic-plasmonic nanostructures (MPNSs) are a promising multifunctional nanomaterial that exhibits enormous potential in advanced applications. However, the saturation magnetization of conventional "gold-coated magnetic" core-shell structured MPNSs is dramatically decreased by the plasmonic components due to the magnetic shielding effect of the gold shell. Thus, the rational design of MPNSs with enhanced magnetic and plasmonic activities still remains a huge challenge. Herein, we report the facile synthesis of magnetic–plasmonic nanoassemblies (MPNAs) which exhibit a typical core–shell structure, wherein oleylamine-coated gold nanoparticles (OA-AuNPs) preferentially aggregate and form a plasmonic core and oleic acid-coated iron oxide nanoparticles (OC-IONPs) assemble a magnetic shell. The resultant MPNAs hold the highly retained magnetic–plasmonic activities for the separation and simultaneous optical sensing of target compounds in complex biological samples.



1. Synthetic procedures of MPNAs.

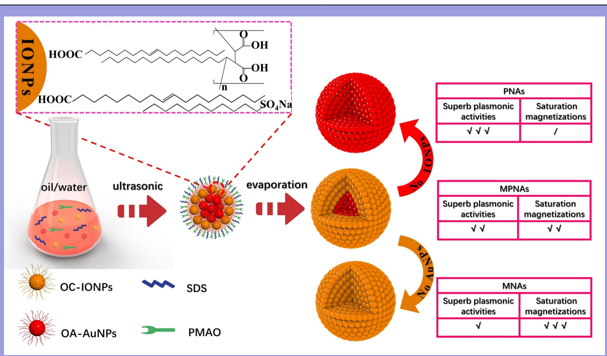


Figure 1. Schematic illustration for the synthetic procedures of MPNAs, PNAs, and MNAs.

2. Characterization of MPNAs.

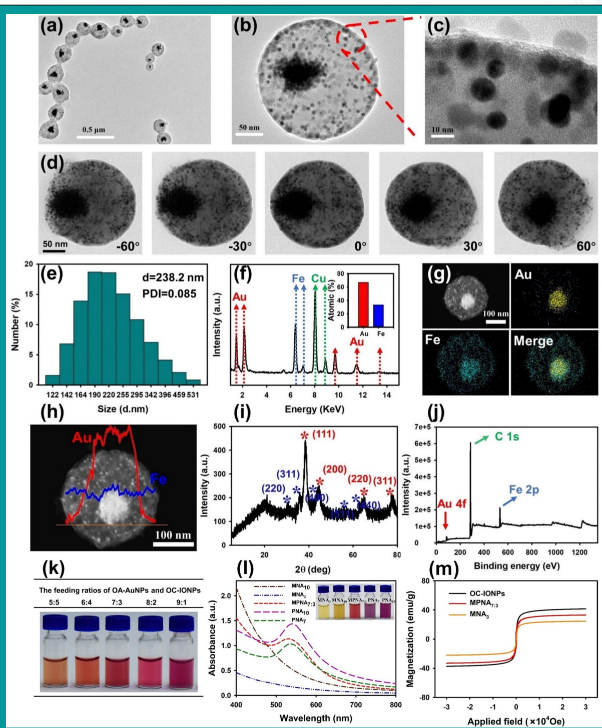


Figure 2. Characterizations of the MPNAs. (a–c) TEM images; (d) Tomographic TEM images; (e) Hydrodynamic Diameter; (f) EDS spectroscopy; (g) HAADF-STEM EDS elemental mapping; (h) EDS elemental line scan; (i) Power XRD pattern; (j) XPS analysis; (k) feeding ration of OA-AuNPs and OC-IONPs; (l) plasmonic activities; (m) magnetic activities.

3. Highly Sensitive Quantification of anti-HCV in Serum.

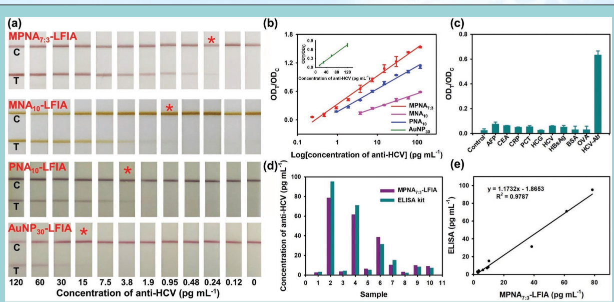


Figure 3. The detection performance of all four LFIA strips, including $MPNA_{7:3}$–LFIA, MNA_{10}–LFIA, PNA_{10}–LFIA, and $AuNP_{30}$–LFIA in the detection of anti-HCV.

Conclusion: We successfully synthesized MPNAs with a "magnetic-coated gold" core-shell heterostructure, which exhibited highly retained magnetic and plasma activity. Using the intrinsic dual functionality of MPNAs as signal transducer and magnetic separator, we demonstrate their potential as bifunctional probes for improving the detection performance on LFIA platform.