FUEL-POWERED CATALYTIC MICROENGINE FOR MOLECULE COLLECTION AND DETECTION

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We design and fabricate a simple micro-system to collect analyte molecules in fluids for surface-enhanced Raman scattering (SERS) detection. The system is based on catalytic Au/SiO/Ti/Ag layered microengines by employing roll-up nanotechnology [1] and the Raman spectrum. Finite-difference time-domain method is employed to illustrate the excitation of localized surface plasmon modes by calculating the electromagnetic field on the rough microengine surface. The bubble-propelled microengines [2] adsorb analyte molecules in fluids, acting as molecule carriers. Pronounced SERS signals are observed on microengines with more carrier molecules compared with the same structure without automatic motions, which indicates outstanding molecule collection performance. Furthermore, optimized collection efficiency of the system is obtained by controlling the fuel concentration. This facile system for molecule collection and detection could spur expanding applications in bioanalysis and lab-on-a-chip research. [3]

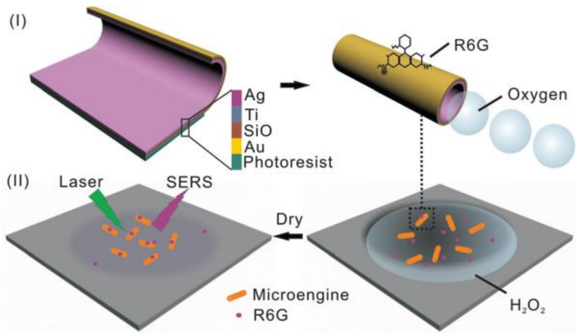

Fig.1 Schematic illustrations: (I) the fabrication process of Au/SiO/Ti/Ag tubular microengines by employing rolled-up nanotechnology and (II) the microengines adsorbed analyte molecules (R6G) in the fluids for SERS measurement..

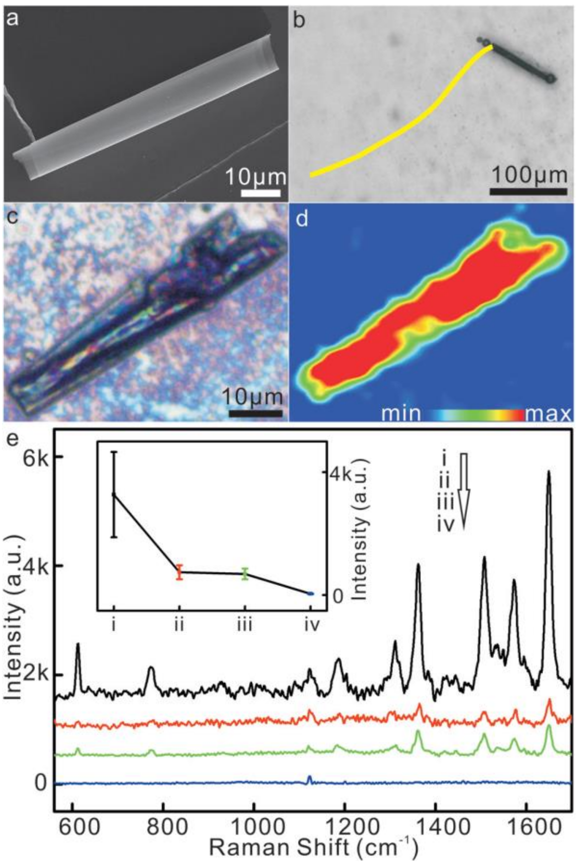

Fig.2 (a) SEM image of a typical single microengine with a diameter of ~8μm. (b) Optical image of the Au/SiO/Ti/Ag microengine trajectory (yellow line) in the presence of a concentration of 3.64% H_2O_2 fuel containing 10^{-6} M R6G. (c) Optical image of a dried microengine after the collecting process in a concentration of 3.64% H_2O_2 fuel containing 10^{-6} M R6G. (d) The corresponding Raman intensity map of the characteristic R6G Raman peak at 1650 cm^{-1} derived from (c). (e) Comparison of SERS spectra of the 10^{-6} M R6G molecules in different cases. R6G molecules collected on (i) active microengines in the system (3.64% H_2O_2); (ii) inactive microengines (without H_2O_2); (iii) microengines fixed on the substrate (3.64% H_2O_2); (iv) a clean silicon wafer without microengines (3.64% H_2O_2). The inset figure shows the quantitative enhancement comparison at 1650 cm^{-1}.

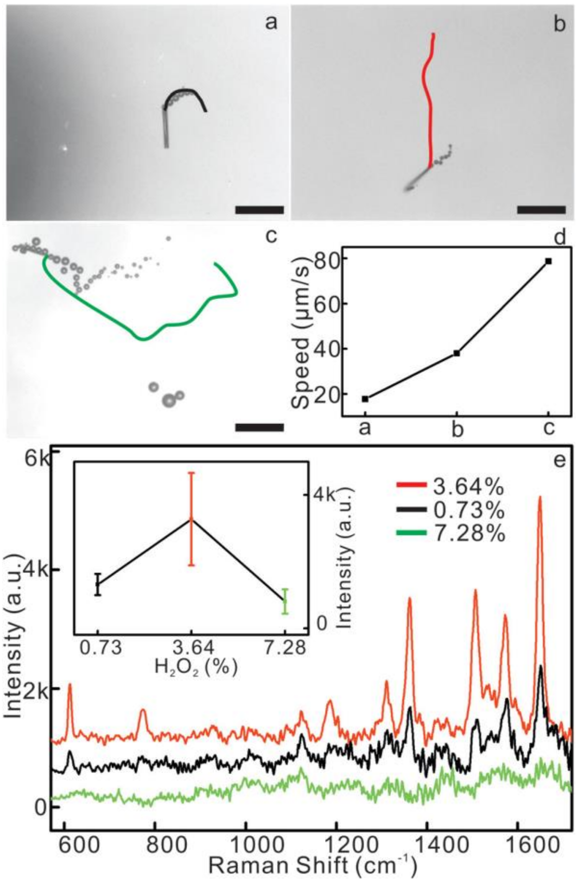

Fig. 3 Optical images of Au/SiO/Ti/Ag microengine trajectories in 7.5s in the presence of a concentration of (a) 0.73% H_2O_2 fuel; (b) 3.64% H_2O_2 fuel; (c) 7.28% H_2O_2 fuel. The scale bar is 100 μm. (d) Speed of catalytic microengines in (a)–(c). (e) SERS spectra comparison of 10^{-6} M R6G adsorbed on the microengines collected in different concentrations of H_2O_2 fuel (0.73%, 3.64%, 7.28%). The inset figure shows the quantitative enhancement comparison at 1650 cm^{-1}.

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