Low Cost SERS Substrate with Silver Nanoparticles on Imprinted Plastic

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Surface Enhanced Raman Scattering (SERS) is a spectroscopic analysis used to detect and identify trace amounts of targeted molecules. The inability to produce large area substrates cost effectively has limited its use in both laboratories and the field. A major goal of this work is the production of low-cost SERS substrates. Sheets of the thermoplastic polyethylene terephthalate (PETE-1)[1] were chosen as the substrate material. The PETE-1 was imprinted using fine grit (1μm) sandpaper as a template (Fig. 1). The imprint fixture was tightened to a pressure of 240 MPa and placed in a 35ºC oven for 12 minutes. The low temperature optimized the depth to which the sandpaper penetrated the PET-1.

A 10% by weight suspension of 10 nmol silver nanoparticles in hexane was purchased as inkjet printer ink.[2] The suspension was diluted 1000 times, and drops were cast onto the PETE-1 substrates. Most of the suspensions spreading on the PETE-1were trapped in pits formed during imprinting (Fig. 2). As the hexane evaporated nearby nanoparticles adhered to each other and self-assembled into nano-spheres. The optimal nano-sphere size, about 80 nm diameter, was obtained with three consecutive drops on substrates imprinted with 1 micron grit sandpaper.

Solutions of the dye Rhodamine 6G (R6G) were used to test the enhancement of the SERS layers. Raman spectra were obtained with a Horiba spectrometer at concentrations from 1 nmol to 1 mmol (Fig. 3). Although a small substrate background is evident, individual R6G peaks can be discerned down to the lowest concentration of 1 nmol.

The cost of materials used in each SERS sample was less than 1 cent. Strong Raman signals were obtained with no expensive equipment and no chemical or lithographic steps. These low costs may be critical concerns to laboratories faced with diminishing funding resources.

[1] Widely available food packaging material

[2] Metallic ink, UTDAg10H, from UTDots, USA.

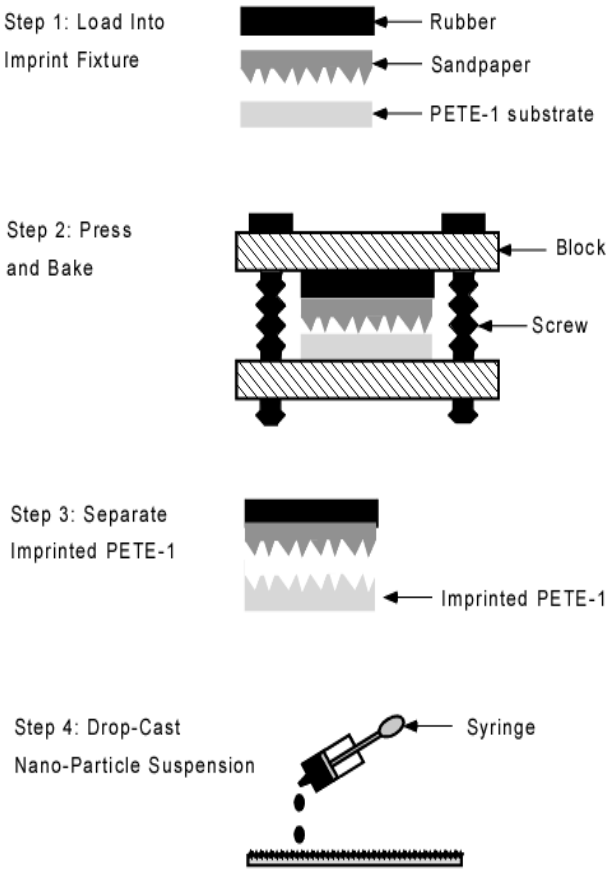

Figure 1: Procedure

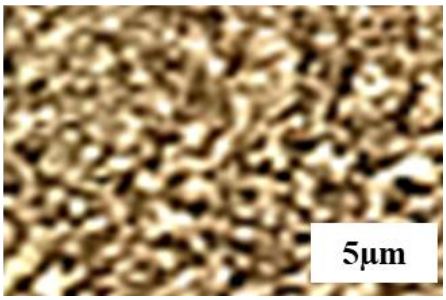

Figure 2: Dye in imprinted PETE-1

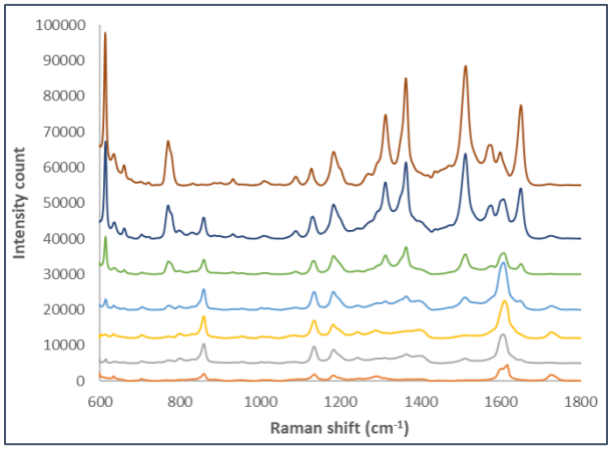

Figure 3: R6G Spectra from 1nmol to 1mmol