MS-3-P-3428 Development of nanoporous substrate PS/Au for SERS.

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PS nanoporous films on low density polyethylene - LDPE were evaluated as substrates for Surface-enhanced Raman spectroscopy (SERS). SERS is a powerful analytical method capable of providing information about the structure of a variety of analytes in a non-destructive way. The sensitivity, reproducibility and stability of the SERS signal depend on the selection of an appropriate substrate(1). Thus, this study demonstrated the formation of a polymeric substrate for SERS from PS nanoporous films covered with Au thin film (sputtered film). Nanoporous films were obtained from 150 µL of a 10% (w/v) PS/THF solution. The solution was placed on LDPE and then rotated at 3000 rpm in spin coating for 10 seconds to generate a PS nanoporous film. Different spin speed, 1000 and 9000 rpm, were also tested. The humidity during the polymer casting was kept constant at 81%. A similar procedure was carried out using chloroform as solvent, which provided a non-porous PS film. Gold thin layers were sputtered on PS film using a current of 6 mA at different times, 10, 5 and 1 min. The efficiency of the nanoporous PS substrate with gold layer deposited for 5 min for generating SERS signal was evaluated using 10 µM 4-mercaptopyridine aqueous solution. AFM images before and after Au deposition of were presented in the Figures 1, 2 and 3. The Au deposition changes the topology of the initial nanoporous film and the nanoporous are not completely filled. Since the conditions 1 and 5 minutes Au deposition of the average depth of the nanoporous remained almost constant compared with the films without the deposition of Au (Figures 1a, 2a and 3a) and (Figures 1, 2 and 3 (c) and (d)). SERS effect of the films obtained in PEBD_PSnanoporous revolved at 1000, 3000 and 9000 rpm, that have average pore size of 303 ± 68, 123 ± 23 and 80 ± 24 nm, respectively, were tested. The result of Raman spectrum for SERS using the substrate obtained at 3000 rpm and 5 minute can be seen in Figure 4. A characteristic 4-mercaptoppyridine Raman bands are verified, intense bands at 1492, 1276, 1100, and 1040 cm⁻¹ (2,3). The great similarity between the spectra of solid 4-mercaptoptyridine (Figure 4 (b)) and 4-mercaptoptyridine in LDPE/Psnanoporous/Au film (Figure 4 (c)) can also be observed. In conclusion, it was possible to synthesize rapid, simple and inexpensive one nanoporous polymeric substrate of PS and Au nanoparticles. The limit of sensitivity of this substrate is being evaluated.

References
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Fig. 1: AFM images and the average Rz of PS nanoporous at 1000 rpm on LDPE (a) without deposition of Au and the following times after deposition of Au (b) 10 (c) and 5 (d) 1 minute.

Fig. 2: AFM images and the average Rz of PS nanoporous at 3000 rpm on LDPE (a) without deposition of Au and the following times after deposition of Au (b) 10 (c) and 5 (d) 1 minute.

Fig. 3: AFM images and the average Rz of PS nanoporous at 9000 rpm on LDPE (a) without deposition of Au and the following times after deposition of Au (b) 10 (c) and 5 (d) 1 minute.

Fig. 4: SERS spectrum of 4 - mercaptopyridine (10-5mol/L) (a) PEBD/PS non-porous/5minAu (c) PEBD/PSnanoporous/5minAu and (b) 4 - mercaptopyridine solid. The wavelength used was 785 nm.