Surface-Enhanced Raman Scattering of Polypyrrole Deposited on Roughened Gold Substrates Modified with Photocatalytic Nanoparticles

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Recently, nanoscale titania is widely investigated owning to its important applications in environmental cleanup, photocatalysts, and solar cells. To increase its photocatalytic efficiency, many methods have been developed to prepare Au-coated TiO₂ nanocomposites. For structural studies, surface-enhanced Raman scattering spectroscopy has recently been used to investigate heterogeneous individual and double-wall carbon nanotubes. Among other techniques used to obtain rough metals substrates, a controllable and reproducible surface roughness can be generated through the electrochemical oxidation-reduction cycles (ORC). Currently, some systems including metal/metal alloy colloids, metal-coated another metal colloids, and metal/adsorbate/metal sandwiches have been developed to further improve the SERS performance. To our knowledge, the effects of TiO₂ nanoparticles on the preparation of a roughened metal substrate and on the corresponding SERS effect have not yet been investigated so far. Since many nitrogen-containing heterocycles with five or six membered rings are known to give strong SERS spectral intensity, gold substrates are originally roughened by the ORC procedure in 0.1 N HCl aqueous solution containing 1 mM rutile TiO₂ nanoparticles under the irradiation of UV light. Then polypyrrole (PPy) films were electrodeposited on the roughened gold substrates to examine the SERS enhancement in this study.

In this study, all the electrochemical experiments were performed in a three-compartment cell at room temperature, 24°C, and were controlled by a potentiostat (model PGSTAT30, Eeo Chemie). Before the oxidation-reduction cycles (ORC) treatment, the gold electrode was mechanically polished (model Minimet 1000, Buehler) successively with 1 and 0.05 µm of alumina slurry to a mirror finish. Then the electrode was cycled in a deoxygenated 0.1 N HCl aqueous solution containing 1 mM rutile TiO₂ nanoparticles under the irradiation of UV light. Then polypyrrole (PPy) films were electrodeposited on the roughened gold substrates to examine the SERS enhancement in this study.

Figure 1 demonstrates the absorbance maximum of rutile TiO₂ nanoparticles, used in this study, appearing approximately at 325 nm. Therefore, the UV irradiation for TiO₂ nanoparticles was kept at 325 nm to promote their catalytic activities. The result shows that the SERS spectrum of PPy electrodeposited on the corresponding roughened gold substrate exhibits higher intensity compared with that without the contribution of TiO₂ nanoparticles in the roughing procedure.

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References