Dendritic Gold Substrates for Surface-Enhanced Raman Spectroscopy

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Gold surface-enhanced Raman scattering (SERS) substrates were prepared by oxidation/reduction cycling in acidified 1.0 mol dm⁻³ KCl solution. SEM investigation of the SERS-activated gold surface revealed the formation of clusters of nanoscale dendrites. The SERS activity generated by the treatment enabled the detection of the vibrational modes of adsorbates present at sub-monolayer coverages.

**Theory of Surface-enhanced Raman scattering**

SERS is a phenomenon by which certain metals, prepared with specific morphologies, enhance the vibrational Raman effect for molecules on, or close to, the surface from 10⁴ to 10⁶ times that of conventional Raman. The evanescent metal oligomers, silver and gold display the most intense enhancement. SERS allows sub-monolayer detection of adsorbates, decreases of trace amounts of analyte, and, under certain instrumental conditions, the detection of single molecules.

**Surface Plasmon Resonance**

The SERS effect is due to interaction of optical radiation with the surface plasmons of the metal substrate, with the frequency of the surface plasmons depends on the size and shape of the nanoparticles. When light of resonance is achieved, to a matching of the plasmon frequency with that of the surface plasmons, surface enhanced Raman scattering (SERS) is obtained. The SERS enhancement is observed as a red shift in the plasmon frequency.

**SERS Activation Procedure**

A gold electrode was electrochemically roughened by applying a cycle of square wave pulses in 1.0 M KCl acidified to pH 3 with HCl in equilibrium with a Pb/PbO₂ reference electrode. The sample was subjected to 15 min pulsing for 101⁷ pulses in a square wave of 101⁶ cycles, while another at 101⁶ cycles as the background electrode. The intensity of the bands has increased by 10⁻³, but is still the background of the scan. The peak at 10⁻⁴ cm⁻¹ occurs at the same time in the background, and in the background, and is still the background of the scan. The peak at 10⁻⁴ cm⁻¹ occurs at the same time in the background, and in the background, and is still the background of the scan.

**Dissolution Kinetics**

Evidence of continued dissolution of the gold surface after leaching for one hour was obtained using kinetic studies of the dissolution process. A polished rotating gold electrode of the same purity as the electrode used for the SERS experiment was leached in an identical thiosulfate solution over a 16 hr period. Samples of the leach solution were extracted hourly for the first five hours and analysed by AAS to determine the rate of gold dissolution. The gold concentration was seen to increase linearly from one to five hours, with a dissolution rate of 10⁻⁴ cm⁻¹ during this period. As the gold is seen to continue dissolving after 5 min, the determination of the gold rate was limited to 5 min. The dissolution of the gold was monitored by AA and AAS to determine the rate of dissolution. The gold concentration was seen to increase linearly from one to five hours, with a dissolution rate of 10⁻⁴ cm⁻¹ during this period. As the gold is seen to continue dissolving after 5 min, the determination of the gold rate was limited to 5 min. The dissolution of the gold was monitored by AA and AAS to determine the rate of dissolution. The gold concentration was seen to increase linearly from one to five hours, with a dissolution rate of 10⁻⁴ cm⁻¹ during this period. As the gold is seen to continue dissolving after 5 min, the determination of the gold rate was limited to 5 min. The dissolution of the gold was monitored by AA and AAS to determine the rate of dissolution. The gold concentration was seen to increase linearly from one to five hours, with a dissolution rate of 10⁻⁴ cm⁻¹ during this period. As the gold is seen to continue dissolving after 5 min, the determination of the gold rate was limited to 5 min. The dissolution of the gold was monitored by AA and AAS to determine the rate of dissolution. The gold concentration was seen to increase linearly from one to five hours, with a dissolution rate of 10⁻⁴ cm⁻¹ during this period. As the gold is seen to continue dissolving after 5 min, the determination of the gold rate was limited to 5 min. The dissolution of the gold was monitored by AA and AAS to determine the rate of dissolution.
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