SERS AND SEM CHARACTERIZATION ON SILVER NANOCUBES WITH VARIOUS SIZES

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Abstract: A chemical reduction method was applied to synthesize silver nanocubes with controlled sizes ranged from 90 to 300 nm. Silver nanocubes were then immobilized on silicon wafers. Using pyridine as the probe molecule, we observed that the SERS activity critically depends on the size of silver nanocubes.

Highly rough surfaces in general are remarkably different from atomically flat (or even stepped) single crystal surfaces in chemical and physical properties. One typical example is that the former generally has substantially higher surface reactivity than the latter. However, it is difficult to develop the theoretical model based on the experimental data obtained from the ill-defined surfaces because of the heterogeneity in the surface structure. To cope with this difficulty, it is worthwhile to construct the atomic-scale well-defined nanostructured surface with well controlled shape and size [1]. This will make the estimation of electromagnetic (EM) enhancement mechanism more simple, and therefore it may provide a method to separate the contribution of the EM and chemical effect mechanisms.

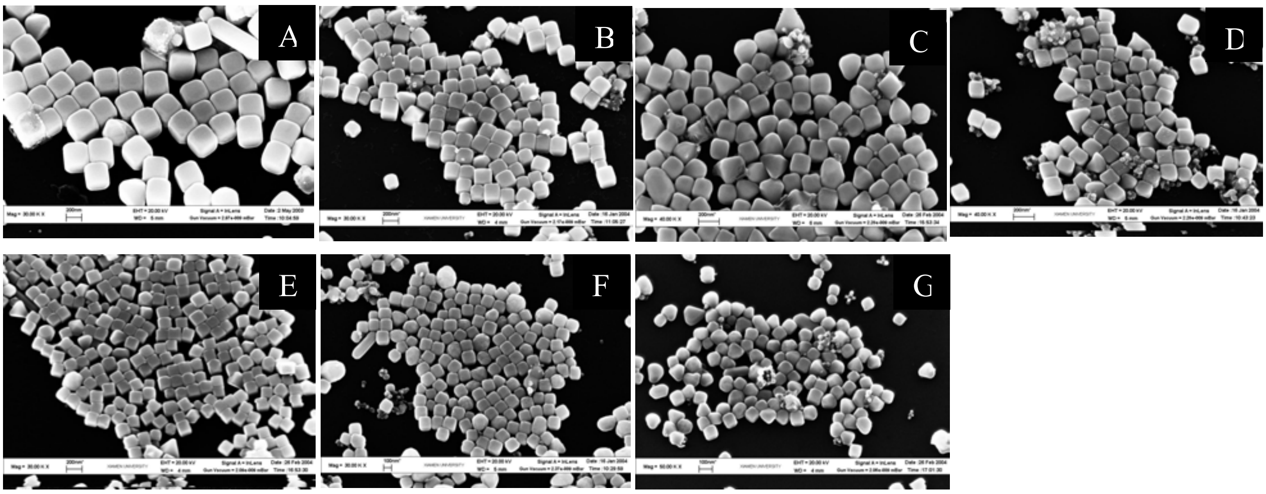

Fig.1.SEM images of silver nanocubes with various sizes on silicon wafers. The edge length of silver nanocubes are: (A) 330 nm, (B) 200 nm, (C) 175 nm, (D) 150 nm, (E) 136 nm, (F) 126 nm, (G) 84 nm.

We have synthesized silver nanocubes with seven kinds of size following the chemical reduction method reported by Sun and Xia [2]. The SEM images of silver nanocubes dispersed over silicon wafers are given in Figure 1. They show very narrow size distribution, with typical edge length of

330 nm (A), 200 nm (B), 175 nm (C), 150 nm (D), 136 nm (E), 126 nm (F) and 84 nm (G), respectively. After separated from a small portion of nanowire and nanorod, a droplet of the nanocube sol was dropped on a silicon wafer, and the silicon wafer was let dry in air over night to allow for a dispersion of submonolayer nanocubes. The silicon wafer covered with silver nanocubes was then used as the SEM sample and SERS substrate. Figure 2 shows the SERS spectrum from silver nanocubes with different sizes by using pyridine as probe molecule. The result indicates that SERS activity critically depends on the size of silver nanocube, and extremely strong SERS signal can be obtained with submonolayer nanocubes of 126 nm. Such kind of electrode also allows the control of the electrode potential over the surface, detailed results will be presented on the conference.

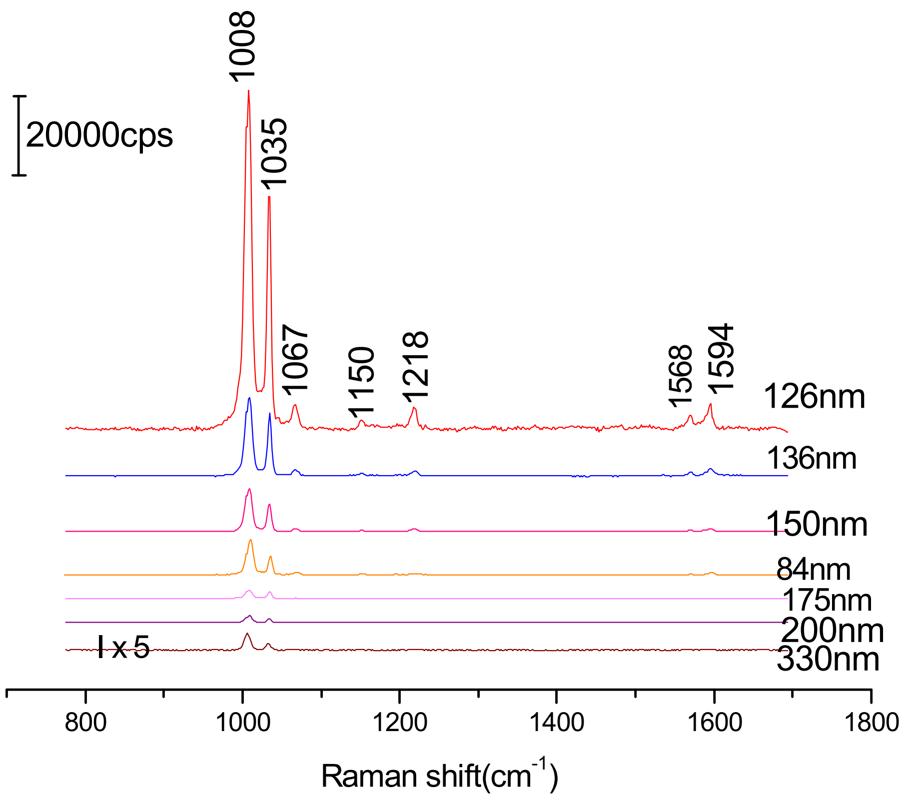

Fig.2. SERS spectra of pyridine (0.01 M) from silver nanocubes with various sizes assembled on silicon wafers. Excitation line: 632.8 nm

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References:

1. Z. Q. Tian, B. Ren, D.Y. Wu, J. Phys. Chem. B **106**, 9463 (2002)
2. Y. G. Sun, Y. N. Xia, Science, **298**, 2176 (2002)