THE SURFACE ENHANCED RAMAN SCATTERING ON CHEMICALLY PURE SILVER COLLOID PRODUCTED BY LASER ABLATION

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Abstract: we prepared silver colloids by chemical reduction of metal salts and laser ablation of pure metals in water. Without any oxidation products and extraneous ions, the ablated silver colloid were high efficient SERS-active substrate compared to the colloids prepared by chemical reduction.

In the field of surface enhanced Raman scattering (SERS), many SERS-active substrates were prepared by chemical reduction of metal salts because of procedure's simplicity and speediness. However, the method could bring about oxidation products and extraneous ions, which result in hindrance of the application of metal colloids as SERS-active substrates in chemical analysis. In order to avoid these problems, with a simple method, we prepared chemical pure metal colloids by laser ablation [1-3].

By the methods above, we prepared two metal colloids to compare the different adsorption behavior of molecules on substrates. The two kinds of silver colloid were prepared respectively according to Lee and Meisel's method [4] and by ablation of Nd: YAG laser [5]. By varying laser pulse energies and ablation time [6], we obtained silver colloidal particles, which have the same range of size distribution of the particles prepared by Lee and Meisel's method. In order to estimate the size of the mental particles prepared by the two methods, we obtained transmission electro microscope (TEM) images for them. The size distribution of the silver colloidal particles were calculated respectively to have the average diameters of 39±12nm(Fig.2a) and 32±5nm (Fig.2b). The Figure.1b shows the ablated silver nanoparticles, which have regular forms, have good dispersing character in solution.

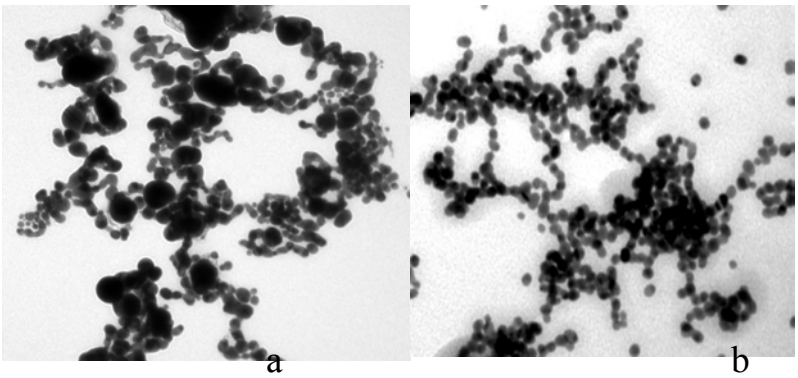

Fig.1. TEM of the Ag colloidal nanoparticles produced by (a) Lee and Meisel's method (b) laser ablation

The two kinds of colloids were used as SERS-substrates when the colloids were fresh. Figure2 shows the Raman scattering spectra of p-hydroxybenzoic acid (PHBA) in different silver colloids.

After introduction of the PHBA into the metal colloidal dispersion respectively, aggregation was caused by direct adsorption of the PHBA molecules on surface of the silver colloidal particles. In the SERS spectrum of PHBA in silver colloid solution, the1580.2 cm^{-1} band and the1630.8cm^{-1} band (Fig.2a), assigned to the CC stretching of benzene, are both very strong , and there are much shifts of these two bands compared with the SERS spectrum (Fig.1a), In Fig.2b ,the intensity of the1368.3 cm^{-1} band, corresponding to the $COO^{\bullet}$ symmetric stretching motions[7], was much stronger than the intensity of the 1366.8 cm^{-1} showed in Fig.1.b.

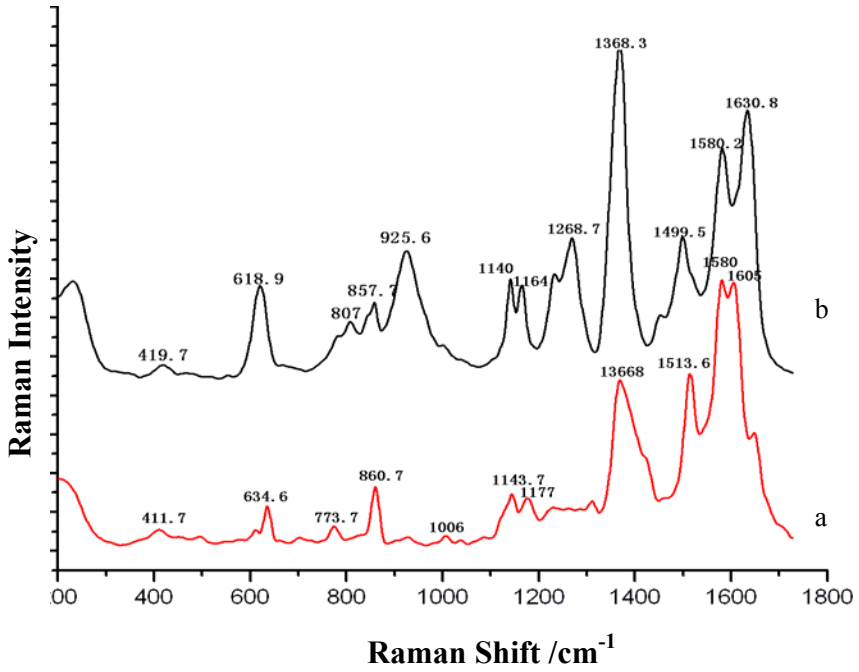

Fig.2.SERS spectra of 1×10^{-4}M PHBA in Ag colloidal solution produced by (a) Lee and Meisel's method (b) laser ablation. Excitation is at 514.5 nm for the solvents.

With well dispersing in solution and uniform size distribution, we can obtain much high quality SERS-spectra from silver colloid produced by laser ablation.

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