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PHOTOEMISSION FROM OBLATE SILVER SPHEROIDS WITH POLARIZED VACUUM UV EXCITATION

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The enhancement of the electromagnetic intensity on the surface of Ag microstructures has been accepted as one of the dominant mechanisms of surface-enhanced Raman scattering (SERS) /1,2/, but the specific enhancement factor resulting from this mechanism has not yet been fully quantified. Photoemission is a technique, besides photoacoustics /3/ or IR absorption /4/, which can be used to clarify the processes involved in SERS.

Photoelectric yield up to a photon energy of 10 eV from ultrafine particles suspended in gas has already been published /5/. For comparison we present in this paper the photoelectric yield of oblate silver particles formed on quartz substrates in the same energy range.

A 3-nm-thick silver film was evaporated on a quartz slide and then heat-treated for 60 s at 400°C. Electron micrographs of these samples showed well-defined particles with circular cross sections of ~60-nm diameter as viewed along the substrate normal. The average center-to-center distance was ~110 nm. Large, tilt-angle, electron micrographs indicated that these particles were flattened out along the substrate normal (Fig. 1). The typical ratio of minor axis lengths to major axis lengths was about 0.2 as determined by the stereoscopic shadowing technique. Photoemission measurements have been made using a Seya-Namioka monochromator with an air discharge lamp. The dependence of the photoyield on the polarization of the incident light has been determined with a vacuum UV transmission polarizer made of cleaved LiF plates.

Figure 2 shows the spectral dependence of the yield Y for oblate Ag particles at room temperature in arbitrary units for two angles of incidence (40° and 70°) for p- and s-polarizations, the electric field in the plane of incidence and perpendicular to the plane of incidence, respectively. Our

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Fig. 1. Electron micrograph of a heat-treated silver film

curves are very similar to those reported by Burtscher et al. /5/. For p-polarization, the Y curves are steep for low $h\nu$, exhibit a flat section at 8 eV < $h\nu$ < 9 eV, and then rise sharply, in contrast to the Y curves for s-polarization which exhibit a gradual, monotonic increase with increasing photon energy. Only above 11 eV do the perpendicular and parallel yields tend towards similar slopes. The flat section in the perpendicular yield can be explained by considering the calculations of the local density of states /6/ which show a distortion of the s-band at the surface such that the density of the s-state is enhanced near E_F but reduced at the bottom of the band.

The photoelectric yield measured on prolate silver spheroids formed on a regular array of SiO_2 posts will also be presented and compared with the above data.

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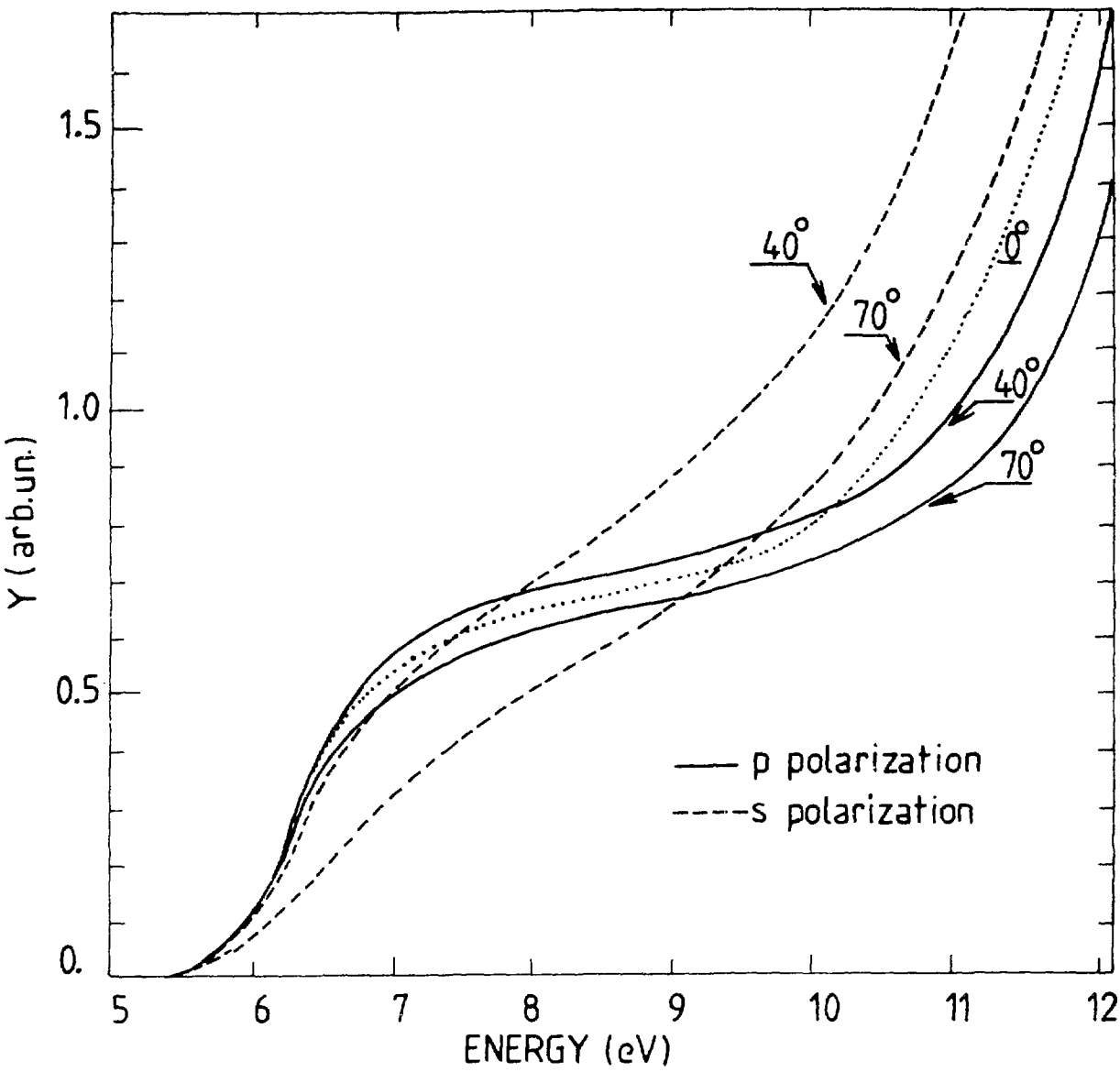

Fig. 2. Photoyield for oblate Ag spheroids as a function of energy

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