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Electrical enhancement of direct-patternable SnO_2 thin films by incorporation of Ag nanoparticles

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Tin oxide (SnO_2) has attracted much attention as a transparent conducting oxide of solar cell and transparent thin film devices. For the application to the electrical devices, an improvement in electrical property of SnO_2 film has been absolutely required. Due to its high conductivity and chemical stability, Ag is widely used for the manufacture of conductive thick film circuits and for the internal electrodes of multilayer ceramic capacitors. In this work, SnO_2 films were prepared by photochemical metal-organic deposition (PMOD) using photosensitive procedures. For the fabrication of electronic circuits, a micro-patterning process is introduced. However the conventional dry etching process is accompanied by generation of physical defects degradation of properties. By using PMOD, photoresist and dry etching was not necessary for microscale patterning, as the coated films behave like the negative photoresist. Ag nanoparticles with a narrow size distribution were prepared by spontaneous reduction method of Ag 2-ethylhexanoate in dimethyl sulfoxide.

According to the incorporation contents of Ag nanoparticles into SnO_2 film, the transmittance and crystallinity of the film was slightly decreased. But, the sheet resistance of the film was improved with an increase of incorporation content. From the valence band spectrum of SnO_2 film containing Ag nanoparticles, we observed that the valence band maximum of the film moved to the Fermi energy level. This corresponds to an increase of electrons in the valence band of SnO_2 film due to electron transfer from Ag nanoparticles to the film. And, direct-patterning of SnO_2 film containing Ag nanoparticles was realized without using photoresist and dry etching. These results suggested that a micro-patterned system can be simply fabricated with low cost and the electrical properties of SnO_2 films can be improved by incorporation of Ag nanoparticles.