E1-11: Quantized nanocrystalline copper (II) oxide films

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Size quantized semiconductor nanocrystalline films are receiving attention, both from fundamental and applied aspects. The confinement of charge carriers to nanocrystallites display novel properties which as band shifts and rapid tunnelling of electrons and/or holes across interfaces. The preparation of nanocrystalline films of CuO and their photoelectrochemical properties is reported.

Nanocrystallites of CuO were coated on conducting tin oxide glass by the following method. A microprous film of CuI was electrodeposited from a solution of CuI + KI in acetone. When the CuI coated glass was sintered in air at 400°C, CuI was converted to CuO. Photoelectrochemical measurements were conducted in deoxygenated as well as oxygenated solutions (Na_2SO_4 or KI) in the 3-electrode configuration. Photocurrent action spectra were recorded using a monochromator-light copper-lock in amplifier arrangement.

Photocurrent action of spectra of nanocrystalline Cu0 films showed the characteristic blue shift compared to polycrystalline films thermally deposited on copper. In the case of nanocrystalline films, photocurrents were significantly enhanced owing to suppression of recombination. Again the photocurrent was found to increase with the increase of oxygen concentration in the solution. This effect arises, because adsorbed oxygen modifies the potential barrier and acts as an electron relay. Adsorbed oxygen to some extent nullified the size quantized blue shift. The size quantized effects depend on confinement of carriers. Adsorbed oxygen favours quantum mechanical tunnelling of carriers across the interface by modification of the potential barrier.

This investigation gives a simple method for preparation of nanocrystalline films of Cu0 and demonstrates the existence of size dependent quantum mechanical effects. Cu0 is superior to Cu_20 in matching of the band gap and the visible spectrum.

However, because of the higher recombination probability, Cu0 films were generally not considered as suitable for solar energy conversion devices. The results suggest the possibility of using nanocrystalline Cu0 in solar cells and other optoelectronic devices.