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Surface treatment of electrodeposited n-type Cu_2O thin films for applications in Cu_2O based devices

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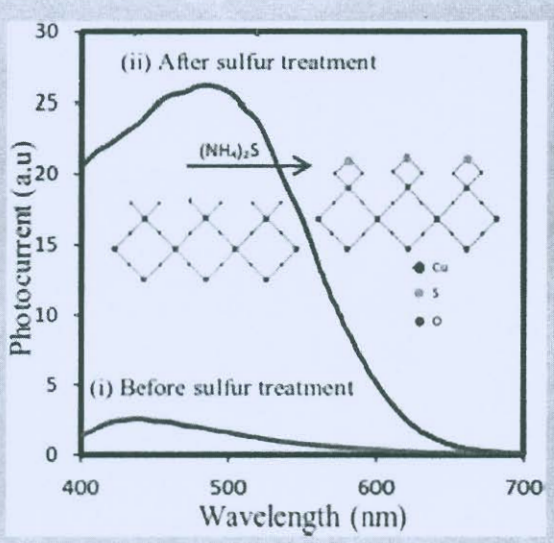
In this Letter, we report the effects of ammonium sulfide $[(NH_4)_2S]$ surface treatment on electrical and optical characteristics of the electrodeposited n-type Cu_2O thin films on Ti substrates. Films characterized structurally and morphologically before and after the surface treatment were compared using conductivity, spectral photoresponse and current–voltage (*I–V*) measurements. The ammonium sulfide surface treatment time showed an impact on optical and electrical characteristics of the films. Treated Cu_2O films exhibited enhanced conductivity giving rise to a 50-fold increase in the photocurrent and improved *I–V* characteristics. It was found that the sulfur passivation resulted in a nearly ohmic behaviour for Au or Ni contacts made with n-type Cu_2O whereas Ag or Cu contacts showed nearly Schottky behaviour. The results showed that ammonium sulfide treatments were very effective to passivate defects and improve the optical and electrical properties of polycrystalline n-type Cu_2O thin films that may provide a solid platform for Cu_2O based devices of enhanced quality.



1 Motivation As an important functional optoelectronic semiconductor, cuprous oxide (Cu_2O) has shown great potential in applications such as electronics, gas sensors, energy, due to its unique electronic and optical properties. The nontoxicity, the low processing cost and the abundance of its component elements in the Earth's crust make Cu_2O even more suitable for such applications [1–3].

Several methods including thermal oxidation, chemical oxidation, anodic oxidation, vacuum evaporation and electrodeposition have been used to prepare Cu_2O films. Among these, electrodeposition is considered the simplest and one of the most convenient fabrication methods. Achievability of higher deposition rates at low processing temperatures and the controllabilty of conductivity type are its added advantages. While electrodeposition does not re-