Enhancement of solar absorption with black Cu2O Nanostructures

HUI XING, JOHN HATCH, DENGXIN JI, KENNETH KORT, BIPLOB BARMAN, YU TSUNG TSAI, YUELING QIN, SARBAJIT BANERJEE, ATHOS PETROU, QIAOQIANG GAN, HONG LUO, HAO ZENG, SUNY at Buffalo — Cu2O is a direct gap semiconductor with a band gap of 2.1 eV. It was considered to be a solar absorber material, while the application is hindered by its large band gap and weak stability. Here we report an electrochemical synthesis of Cu2O. By rationally control the synthetic parameters, we achieved two types of Cu2O: one of black color and the other “normal” red Cu2O. Both Cu2O films were in cubic phase and their crystal structures are almost identical as seen by X-ray diffraction. This is further corroborated by their nearly identical Raman spectra. The scanning tunneling spectrum (STS) revealed a gap in the red Cu2O around 2.1 eV and a significantly lowered gap of ~1.7 eV in the black Cu2O, indicating that the black color is caused by a change in the electronic structure. The reflectance and transmittance indicated a band gap of ~1.7 eV for the black Cu2O, with a significantly broadened absorption spectrum. While further effort is needed to understand the mechanism for the lowering of the band gap, we believe that our approach demonstrated means to promote earth abundant and nontoxic materials for potential photovoltaic applications through band gap engineering.

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