Hard-hydrophobic nano-CuO coating via electrochemical oxidation for heat transfer performance enhancement

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ABSTRACT

The heat transfer performance of a material is mainly affected by the surface-to-volume ratio and specific surface area. This paper presents an evaluation of hard-hydrophobic nano-CuO coating on the heat transfer performance of copper. Granular coating consisting of nano-sized CuO grains was developed using the electrochemical oxidation method in 0.1 M oxalate solution at ambient temperature. The nano-CuO coating was characterized using electrical resistivity meter, X-ray diffraction, energy-dispersive X-ray Spectroscopy, cyclic voltammetry and field emission scanning electron microscopy. The average grain size of the coated material was 47 nm with an average coating thickness of 13 µm. The nano-CuO-coated samples' thermal resistance was lower than that of the uncoated specimens with an increment in thermal conductivity. The nano-CuO coating demonstrated a hard coat with a hydrophobic characteristic feature on the surface. The maximum coatings hardness attainment was 178 H.V. The nano-coating also enhanced the efficiency of heat transfer (ΔQ%) by ~ 95%. This enhancement was due to the increase in the specific surface area by 272 times, which in turn increased heat transfer performance across the nano-coated surface by about 22 times compared to the uncoated surface. This result confirmed the feasibility of this current hard-hydrophobic nano-CuO coating for enhancement of hardness, hydrophobicity, and heat transfer performance of the copper material in cooling and heating technology, especially for the reduction in the required size of heat transfer equipment, increasing reliability, and improvement of surface protection characteristics.

KEYWORDS

Hard-hydrophobic coating; Heat transfer performance; Nano-CuO coating; Specific surface area

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