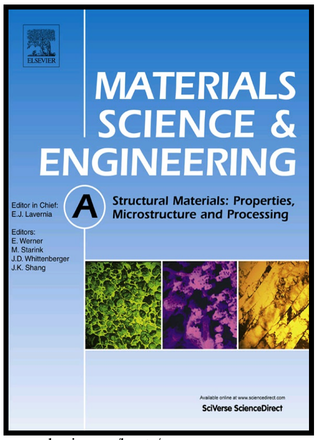

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Microstructure and compressive behavior of ice-templated copper foams with directional, lamellar pores

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Abstract

Copper foams are fabricated by directional freezing of aqueous suspensions of nanometric CuO powders followed by ice sublimation, reduction to Cu in Ar–5% H_2 gas and sintering. During slurry solidification, parallel, lamellar, centimeter-long ice dendrites grow, pushing the CuO powders into lamellar interdendritic spaces. Upon subsequent ice sublimation, the ice dendrites create lamellar pores surrounded by CuO walls that are subsequently reduced to copper and sintered; these ice-templated walls display surface micropores and, depending on the reduction/sintering parameters, internal micropores. Varying the main processing parameters – powder fraction in the slurry (from 13 to 19 vol.%) and casting temperature (from -10 to -30 ºC) - has a strong effect on the foam microstructure: (i) porosity (varying from 45 to 73%) is inversely related to slurry powder fraction, (ii) oriented lamellar macropores width increases from 15 to 64 μm with decreasing slurry fraction and increasing freezing temperature and (iii) oriented lamellar Cu wall width increases from 19 to 63 μm with increasing slurry fraction and freezing temperature. The resulting Cu foams show oriented, lamellar macropores (beneficial to permeability) and walls micropores (which increase the surface area) and are promising for use in electrochemical cells given the