

# Mechanical Engineering Thesis Defense

Mechanical and Electrical Properties of High Conductivity, High Strength Copper Material with Fine and Ultra-Fine Grain Size at Room Temperature

School for Engineering of Matter, Transport and Energy

**Jackson Opoku**

Advisor: Dr. Leila Ladani

## Abstract

Nanostructured (NS, grain size ( $d$ )  $< 100\text{nm}$ ) and ultrafine grained (UFG,  $d < 500\text{nm}$ ) metals possess superior mechanical and electrical properties over coarse grained (CG,  $d \gg 1\mu\text{m}$ ) metals. The strength of metals like copper (Cu) has been shown to be significantly improved when engineered to have fine and ultrafine grain sizes via processes such as cryomilling, isostatic pressing and C-ECAP. This study investigates the mechanical and electrical properties of laboratory scale copper (Cu) conductors and how its strength is affected by a variety of parameters when tested in uniaxial tension. The copper material is fabricated through cryomilling, cold isostatic pressing and Continuous Equal channel angular pressing (C-ECAP). Several tests such as nanoindentation and electrical tests were performed to investigate the effects of manufacturing and testing parameters on the material. Pre and Post fabrication examination of the material with 3D-xray tomography, optical and electron microscope were conducted to gain deeper understanding of the effects of the processing parameters on the material during fabrication. While the material showed improved strength and hardness compared to conventional copper material at room temperature, its ductility decreased rapidly to about 10%. The hardness was observed to be increasing along the direction of ECAP. Also, higher ECAP temperatures produced materials with higher electrical and mechanical properties. A constitutive model based on Joshi's model of plasticity and multilinear isotropic hardening were developed to model and describe the material behavior using Mechanical APDL.



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Zoom Link: <https://asu.zoom.us/j/86939820895>