Graphene-reinforcement of CuW composites for high-voltage circuit breaker applications

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Copper tungsten (CuW) composites have garnered great interest as a contact material for high voltage circuit breaker (HVCBs) due to Cu's high electrical conductivity, and W's high melting point and low coefficient of thermal expansion.[1][2] However, due to the poor mixing of Cu and W, CuW composites are highly heterogeneous, resulting in poor performance.[2] In this work, graphene reinforcement of CuW composites is studied by introducing graphene fillers during composite preparation. Composites with graphene (GCuW) and without graphene were prepared via sintering, and their surfaces examined via SEM, Raman spectroscopy and confocal microscopy. Composite samples were repeatedly subjected to high current arcing conditions (5 kA), with their surface morphology studied after each phase of arc testing. Graphene fillers were shown to be distributed predominantly throughout the Cu phase of the GCuW composites. A decrease in the size of the initial W grains, and more homogeneous distribution of Cu and W, was observed for GCuW composites with just 0.02 wt% graphene loading, suggesting improved mechanical performance and anti-arc erosion resistance owing to an increase in grain boundaries in the composite. This improvement is observed via persistence in defined surface microstructure in GCuW composites following the first phases of arc testing (fig. 1). Surface roughness measurements taken via confocal microscopy measure a lower average roughness for GCuW composite contacts compared to CuW composite contacts as the number of arcing tests increases, indicating reduced arc erosion during operation. This improved anti-arc erosion performance of GCuW composite HVCB contacts suggests extending operational lifetime, reducing costs for maintenance and replacement.

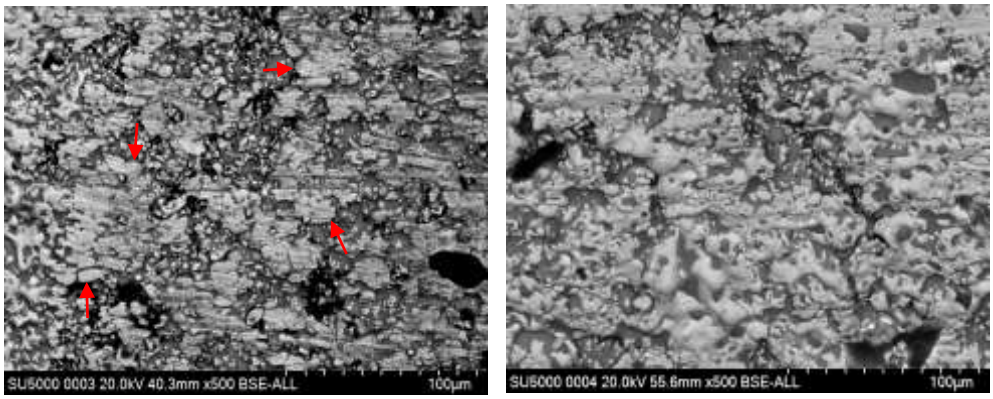

Figure 1: SEM images showing (left) GCuW contact surface and (right) CuW contact surface after single 5 kA shot, with some remaining W grains indicated.

References

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