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Designing new ultra-radiopure, high-strength electroformed Cu-based alloys, for rare event searches

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Several search approaches have been employed for Dark Matter (DM), with "direct detection"being one of the most prominent. It aims to observe DM from the Milky Way halo via its coherent elastic scattering off a nucleus.

Electroformed copper (EFCu) is a material of choice for large-scale detectors thanks to its favorable radiochemical, thermal, and electrical properties. To fulfil the unique radiopurity requirements, experiments pioneer large-scale, additive-free Cu electroformation. This novel technique leads to extreme radiopurities with contamination below 10-14 grams of 232Th and 238U per Cu gram. However, Cu is highly ductile and of low strength, limiting its use for moving mechanical, high-pressure, and load-bearing parts.

Our work addresses materials challenges by developing high radiopure Cu-based alloys with significantly higher strength compared to Cu. This would improve the capability for experiments such as DarkSPHERE, a large-scale fully electroformed underground spherical proportional counter operating under high pressure to probe uncharted territory in the search for DM. It is also vital for other rare event searches, including searches for neutrinoless-double β-decay.

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