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ENGINEERING

Processing Manipulation of Carbon Content in Cu-34.6%Mn

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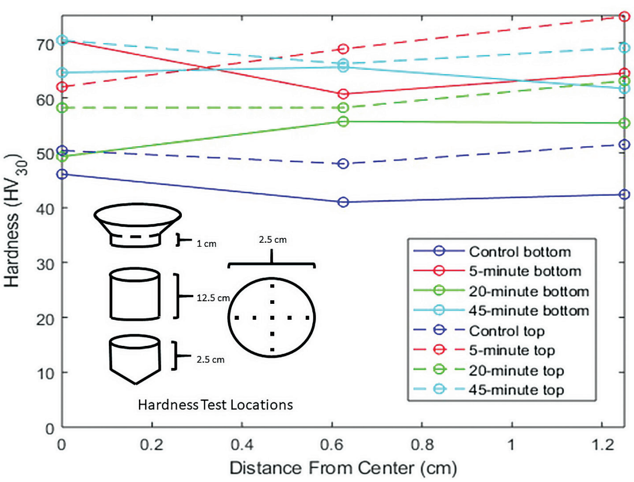
This work attempts to identify the dependency of hardness and particle concentrations on testing locations and graphite exposure times. This will help identify optimal processing parameters to maximize hardness and alloy viability. Noted in the 2014 article, "Structure and Properties of Cast Near-Congruent Copper-Manganese Alloys" in *Metallurgical and Materials Transactions B*, Chaput and Trumble designed a copper-manganese (Cu-34.6%Mn) alloy that has been shown to contain soft graphite and hard manganese carbide (Mn_7C_3) phases when exposed to graphite during casting. The graphite has been hypothesized to act as a lubricant in bearings, replacing toxic leaded brasses. Additionally, copper often has microbially resistant properties, but is too soft unalloyed. The alloy's increased hardness could increase viability for use in hospitals or kitchenware.



Vickers hardness measurements for samples cut from top and bottom of each cast sample with graphite exposure time labelled and plotted relative to distance from the center of the cross section. Cross-section and hardness test locations are shown in the lower left.

The alloy was consistently harder when exposed to graphite than the unexposed control, as seen in the accompanying image. No significant comparisons could be made between samples exposed for different times. The top half of the ingot was harder. The highest hardness measurements were observed furthest from the center of the cross section. Both hardness increases occurred in regions of quicker solidification. More carbide particles were found further from the cross-section center.

To increase hardness, the solidification rate could be increased, replicating the harder exterior and top portions of the sample. As the five-minute exposure samples had similar hardness to the forty-five-minute samples, shorter exposure times still provide viable mechanical properties. Increased solidification rates and decreased exposure times increase production speed, therefore decreasing production cost. Higher particle concentrations near the exposed surface provide viability for lubrication properties. The findings recommend increasing solidification speed and support the potential of the alloy for uses in bearing and sanitary applications.

Research advisor Kevin Trumble writes: "Samuel's research showed a viable route through which the properties of the new Cu-Mn casting bronze can be tailored to specific applications by varying the casting conditions. Besides advancing the fundamental understanding of processing-properties relationships, his work has helped to accelerate commercialization of this alloy for lead-free bearings, plumbing fittings, and antimicrobial applications."

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