Title:

Recycling of aluminium bronze chips for additive laser directed energy deposition

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Abstract:

In the post-processing of large maritime components, significant waste is generated in the form of milling and grinding chips. Meanwhile, additive manufacturing technologies have demonstrated considerable potential for producing high-volume parts in maritime applications, facilitating innovative design strategies and reducing lead times.

This study proposes a sustainable method for recycling aluminum bronze waste material, generated during the post-processing of large cast ship propellers, to serve as feedstock for laser powder directed energy deposition. The recycling process employs inductive re-melting combined with ultrasonic atomization to produce powder batches. The resulting metal powders are analyzed through digital image analysis, powder flowability tests, SEM, and EDX. Compared to conventional gas-atomized metal powders, the recycled material exhibits excellent sphericity and a particle size distribution with a higher proportion of fine particles, which slightly impacts powder flowability. Metallographic examinations of additively manufactured specimens indicate competitive density values ($\rho > 99.8\%$) and enhanced hardness ($\approx$ 260 HV1 vs. 170 HV1) compared to cast material properties. Although tensile tests reveal a relatively brittle structure with a fracture elongation of $\varepsilon \approx 9\%$, the material demonstrates high yield strength ($Rp0.2 \approx 650$ MPa) and tensile strength ($Rm \approx 850$ MPa). This process chain holds significant promise for advancing circular and sustainable manufacturing within the maritime sector.