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Selective laser melting of recycled Al95Fe2Cr2Ti1 quasicristalline phase former alloy

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The precipitation of a quasicrystalline phase (QC) in an ?-Al dendritic matrix provides Al-Fe-Cr-Ti alloys with high mechanical strength and wear resistance, mainly at high temperatures, which are promising for applications as automotive and aeronautical engine parts. However, to form the quasicrystalline phase, a high cooling rate must be applied during solidification (~103 K/s), which usually limits the sample size to powders and thin ribbons because of their reduced thickness. Engine parts typically present complex geometry, being fabricated through casting and/or machining processes, with limited design possibilities. An alternative route to produce these components is using additive manufacturing, where the part is built layer by layer, which allows the production of parts with complex geometry and internal cooling system. Among the additive manufacturing processes, there is Selective Laser Melting (SLM). This process, besides allowing the production of parts with complex geometries and customized density, also allows achieving high cooling rates (up to 105K/s), which may allow obtaining quasicrystalline phases in Al-based alloys. The present project aimed to investigate the processability of the recycled Al95Fe2Cr2Ti1 quasicrystalline phase former alloy by the SLM process and to understand its phase formation, microstructure, and mechanical properties. A detailed study was made aiming to obtain samples containing the quasicrystalline phases with a size suitable for compression tests. The Al95Fe2Cr2Ti1 powder and also the parts built by SLM were characterized regarding microstructure, mechanical and thermal stability by X-ray diffraction, differential scanning calorimetry, optical microscopy, scanning and transmission electron microscopy, energy dispersive spectrometer, density, compressive test at different temperatures and hardness. The Al95Fe2Cr2Ti1 powder presented suitable physics characteristics to be applied in the SLM process as circularity, aspect ratio, and flowability. Samples built using optimized SLM parameters showed compressive resistance of 913 MPa at room temperature and 268 MPa at 400 °C. The samples presented a homogenous and refined microstructure rich in icosahedral QC phases. These results revealed an excellent opportunity to produce large parts with different designs of metastable quasicrystalline phase former alloys.