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Additive manufacturing of high-alloy austenitic steels with equiaxed fine-grained microstructure

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Powder bed-based processing of austenitic stainless steels either by laser (SLM/LB-PBF) or electron beam (EBM/EB-PBF) results often in a columnar microstructure with strong texture caused by the high temperature gradient from the heat input perpendicular to the build platform. Resulting anisotropic mechanical properties are undesirable for the majority of applications. One way to prevent large columnar grain structures is to influence the solidification during the layer-by-layer additive manufacturing process by specific adjustment of the alloy composition. The present study shows the transition from columnar to fine-grained microstructure for various high-alloy austenitic steels including TRIP (TRansformation Induced Plasticity), TWIP (Twinning Induced Plasticity) and Q&P (quenching and partitioning) steels. All additively manufactured steels exhibit good mechanical properties in spite of manufacturing defects such as high strength and/or high ductility and a high damage tolerance.

Keywords: Additive manufacturing, Powder bed fusion, Selective electron beam melting, Austenitic stainless steel, Isotropic microstructure

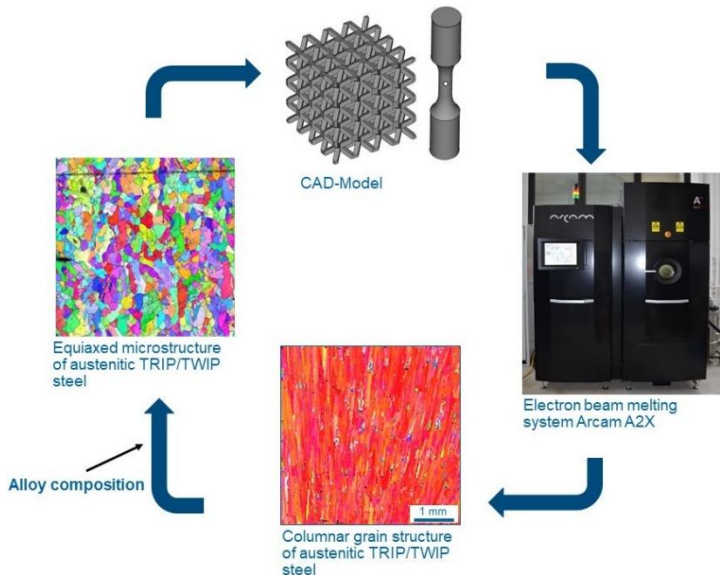

Fig. 1 Transition from columnar to fine-grained microstructure in SEBM by specific adjustment of the alloy composition