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ABSTRACT:

Opportunities and challenges of EBM

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Electron Beam Melting (EBM) is an additive manufacturing technique that is increasingly gaining importance, particularly in the field of metal processing. The process builds components layer by layer from metal powder, which is selectively melted by a focused electron beam under vacuum conditions. One of the primary advantages of EBM lies in its ability to produce complex, functionally optimized structures without support structures. Examples include lattice structures designed for weight reduction, which are often challenging or impossible to fabricate using conventional manufacturing methods. The process also offers high material efficiency, as only the material required for the component is melted. Furthermore, EBM typically induces lower residual stresses compared to Selective Laser Melting (SLM), due to the elevated temperatures at which the process operates. This helps to minimize the risk of warping or crack formation. Conducting the entire process within a vacuum chamber also reduces oxidation and ensures a stable manufacturing environment.

Despite these advantages, several challenges remain. High initial equipment costs, a limited range of suitable materials, and often comparatively low surface quality of as-built components are notable limitations. Consequently, additional post-processing steps are frequently required to achieve the desired surface finish or dimensional accuracy.

Nevertheless, early research indicates that components produced via EBM can exhibit excellent mechanical properties. In particular, titanium alloys have demonstrated high strength and a homogeneous microstructure, making the technology especially attractive for safety-critical applications, such as in the medical and aerospace sectors.

Keywords electron beam melting, additive manufacturing, titanium alloys, material efficiency, mechanical properties