Contribution ID: **11** Type: **Oral Presentation - a full paper will be submitted**

Additive manufacturing of hot-work tool steel by in-situ alloying using laser powder bed fusion and directed energy deposition – Strategies to improve chemical homogeneity

Tuesday, 25 March 2025 10:50 (20 minutes)

The production of complexly shaped parts like molds with integrated cooling channels by additive manufacturing represents a promising approach by eliminating the need for specific tooling, reducing lead times, and minimizing the material footprint. Unfortunately, typical carbon-martensitic steels used to produce such components often suffer from crack formation during additive manufacturing processes associated with steep thermal gradients and fast heating and cooling cycles. To prevent cracking of parts additively manufactured from carbon-martensitic steel adjustments in alloy design can be made. A promising approach to modify the composition of available starting powders and to develop novel alloys is in-situ alloying. Thereby, the desired alloy is formed during the additive manufacturing process from a mixture of different precursor powders. This, however, often results in chemically inhomogeneous parts due to incomplete dissolution of powder particles and insufficient intermixing of alloying elements within the melt pool. Thus, the present work investigates the possibility of improving the chemical homogeneity of an in-situ alloyed hot-work steel powder mixture including ferrotungsten and ferromolybdenum as precursor materials since those have proven challenging to be homogenized using standard additive manufacturing process parameters. On this basis, both, the effect of re-melting in PBF-LB/M by applying double laser exposure and enlarged melt pools by DED-LB/M on chemical homogenization were analyzed with reference to single exposure PBF-LB/M processing. The chemical homogeneity is assessed statistically by calculating Gini coefficients based on large scale 2D-EDS data. Furthermore, the local hardness in heat-treated condition is compared and related to the chemical homogeneity. Thereby, this work gives a guideline to which extent chemical inhomogeneities resulting from in-situ alloying can be tolerated with regard to mechanical properties and local defect formation. The findings indicate that applying re-melting in PBF-LB/M is promising to produce parts of high geometric accuracy from powder mixtures containing even high-melting precursor materials.

Speaker Country

Deutschland

Are you interested in publishing the paper in a Steel Research International special issue?

Yes

Primary authors: GROßWENDT, Felix (Ruhr-universität Bochum); Prof. WEBER, Sebastian (Ruhr-Universität Bochum); Dr LENTZ, Jonathan (Ruhr-Universität Bochum)

Presenter: GROßWENDT, Felix (Ruhr-universität Bochum)

Session Classification: Additive Manufacturing

Track Classification: Processing: Additive manufacturing of tools