Contribution ID: **19** Type: **Oral Presentation - a full paper will be submitted**

Sliding wear and nitriding behavior of HWTS 50 tool steel tailored for L-PBF process

Tuesday, 25 March 2025 11:10 (20 minutes)

This manuscript investigates the properties and performance of Osprey® HWTS 50, a lean hot work tool steel with 0.22 mass % carbon, in contrast to standard AISI-H13 and H11 grades (˜0.4 mass %). The steel was manufactured using the laser powder bed fusion process (L-PBF) and subjected to sliding wear tests as well as gas nitriding. Three different conditions were evaluated: as-built (AB), directly double tempered from AB (DT) at 50±2 HRC, and quenched and tempered (QT) at 50±2 HRC. The wear performance of HWTS 50 was compared with an additively manufactured maraging steel of 18Ni300 type in peak-aged condition (˜54 HRC) and a wrought H13 counterpart tempered to 50±2 HRC. The results indicated that the wear damage in HWTS 50 variants is comparable or slightly lower compared to the wrought H13 counterpart. Additionally, it was observed that all carbon-containing hot work tool steels outperformed the carbon-free 18Ni300 steel. Gas nitriding was carried out on AB, DT, and QT specimens. For comparison, gas nitriding was also performed on electro-slag remelted (ESR) H13 and H11 steels, which were tested under the same conditions. The results from the nitriding experiments showed that in all HWTS 50 variants, surface hardness was comparable to the wrought counterparts. However, the nitriding hardness depth (NHD) was significantly larger than that of ESR H11 and H13. This was attributed to the lower contents of elements Cr (˜3 mass%) and V (˜0.5 mass%) in HWTS 50, which enhance the diffusion of nitrogen, and the increased dislocation density inherent to the L-PBF- process, which may enhance the diffusion kinetics. Microscopic analysis revealed a more extensive compound layer (approximately 10 µm vs. 4 µm) and diffusion zone in HWTS 50 compared to other steels. XRD analysis on the nitrided surface demonstrated comparable phases, including Fe2N and Fe4N, in all alloys.

Speaker Country

Germany

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Session Classification: Additive Manufacturing

Track Classification: Processing: Additive manufacturing of tools