Contribution ID: **63** Type: **Oral Presentation - a full paper will be submitted**

# Mean stress sensitivity for carbide-rich PM tool steels under axial and torsional loading

*Tuesday, 25 March 2025 17:10 (20 minutes)*

Designing cold-work tools against fatigue fracture under uniaxial and multiaxial cyclic loading is of great economic relevance for industry to increase the productivity in metal cold forming processes. To implement more resource-efficient and low-emission production chains, minimizing retooling times, increasing tool service lifes and produced quantities per tool is of particular interest to society. Apart from wear resistance, the fatigue strength of carbide-rich, high-alloyed tool steels is the important lifetime-limiting factor.
As reported in the literature, tools in massive cold forming of complex shaped parts often fail due to fatigue fracture. In the design of cyclically stressed tools made of carbide-rich tool steels, besides factors influencing the fatigue properties such as the degree of multi-axiality, possible non-proportionality, notch effect or microstructural features, it is necessary to consider characteristic material properties such as the mean stress sensitivity (M) and the ratio of torsional to axial fatigue strength (D). So far, these material properties have not been studied sufficiently, which makes it difficult to evaluate tool service lifes under real operating conditions.
In this work, HCF fatigue properties under axial and torsional loading with systematic variation of the stress ratio are presented for the powder metallurgical (PM) steels M3, D2 and V10. In addition, the crack-initiating defects are identified and correlated with the fatigue strength according to Murakami's model. It is shown that the fatigue strength is directly related to the steel cleanliness and the manufacturing-dependent defect sizes. Based on the results, new material-specific correlations for HCF strength, M, D and Haigh diagram plots are introduced.

## Speaker Country

Germany

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

Yes

**Primary author:** Mr SCHOLL, Lennart Mirko (RWTH Aachen University)

**Co-authors:** Mr TEGEDER, Frederik (RWTH Aachen University); Mr BEZOLD, Alexander (RWTH Aachen University); Prof. BROECKMANN, Christoph (RWTH Aachen University)

**Presenter:** Mr SCHOLL, Lennart Mirko (RWTH Aachen University)

**Session Classification:** Fatigue

**Track Classification:** Production: Tool materials with higher performance