SUCCESS STORY

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IC-MPPE
Integrated Computational Materials Process and Product Engineering.

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HOT-STUFF: RECYCLING OF TOOL MATERIALS

ENSURING HIGH-QUALITY PERFORMANCE OF METAL-CUTTING TOOLS MADE FROM RECYCLED MATERIALS THROUGH HIGH-TEMPERATURE MATERIAL TESTING IN VACUUM

In the production of metal workpieces in cutting processes, metalworking tools made of WC-Co hard metals are widely used. These materials contain large amounts of the critical raw materials tungsten and cobalt. Due to an instable supply situation and rising prices because of geopolitical uncertainties, recycling of these metals plays a crucial role. It enables the sustainable and cost-effective production of metal-cutting tools that are essential in many areas of industrial manufacturing.

To ensure that metalworking tools produced with very high shares - up to 99% - of high-quality recycled tool materials (Ceratizit upGRADE) offer properties equivalent to those of state-of-the-art materials with the same nominal composition and microstructure, the Sec3T project was carried out.

The goal of the project was to quantitatively compare the deformation and damage behavior of WC-Co hard metals under conditions present at the cutting edges of milling and drills tools during chip formation in metal machining for materials with different shares of recycled content. A key question was whether the upGRADE material, with its particularly high recycled material content, does accumulate plastic strain and damage more rapidly than conventional material.

To answer this question, advanced materials-testing methods were used that are unique in Europe. These methods make it possible to apply static and cyclic tensile and compressive loads to cemented carbide at temperatures of up to 800°C in a vacuum environment. This ensures that the material properties are not altered during testing by contact and reaction with atmospheric oxygen, i.e. material oxidation is prevented.

In addition to analyzing the size distribution of WC grains in the material, several key material properties

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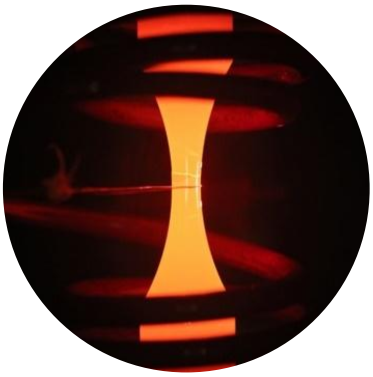
were compared. These included the load limits for permanent deformation (plasticity) under increasing stress and the rate of deformation under constant load (creep) as a function of the testing temperature. The rate of deformation under repeated loading at 700°C and 800°C was also examined. For all tested loading scenarios, the properties of the state-of-the-art material and the upGRADE material showed very good comparability.

Impacts and Applications

The benefits generated by the project lie in providing a knowledge-based validation of a large-scale strategy for reusing tool materials that have already been used in industrial service. The results help determine whether adjustments are needed in manufacturing processes that rely on cyclical material reuse at the industrial partner Ceratizit Austria GmbH.

The project also helps build trust among potentially skeptical customers. Acceptance of recycled materials by customers and by users of these tools in industrial manufacturing processes is essential for achieving climate and environmental protection goals as well as efficient resource use.

The circular economy supported by this work plays a crucial role in securing supply chains, reducing CO_2 emissions, and decreasing dependence on external raw-material sources in politically unstable regions. Notably, the production of recycled hard metals costs significantly less resources and requires three times less energy, making an important contribution to maintaining Austria as a competitive manufacturing location.



Material testing at 800°C in a vacuum to prevent sample oxidation. Copyright MCL.

Project Coordination (Story)
Dr. Thomas Klünsner
Group Leader Hard Metals
Materials Center Leoben Forschung GmbH
T +43 (0) 3842 45922-472
thomas.kluensner@mcl.at

IC-MPPE / COMET-Zentrum
Materials Center Leoben Forschung GmbH
Vordernberger Straße 12
8700 Leoben
T +43 (0) 3842 45922-0
mclburo@mcl.at
www.mcl.at

Project Partner

- Ceratizit Austria GmbH, Austria
- Materials Center Leoben Forschung GmbH, Austria

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