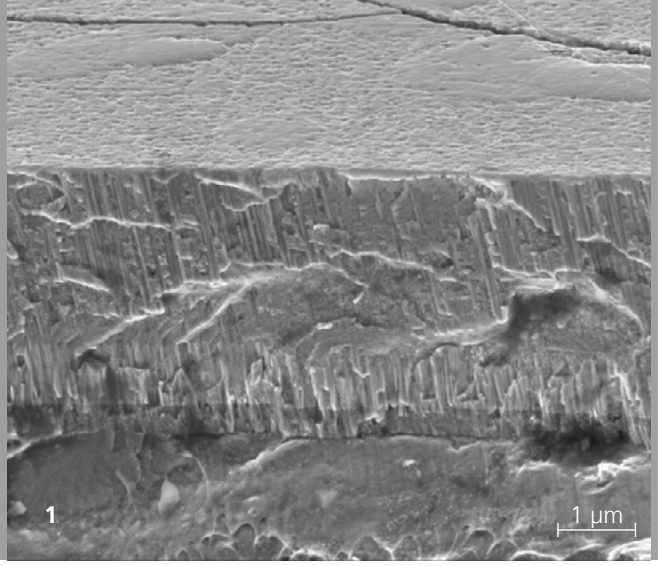

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# FORMING TITANIUM ALLOYS EFFICIENTLY

Currently efficient technical forming processes, such as deep-drawing or hydroforming, can only be used for titanium alloys with severe restrictions. The high adhesion tendency of titanium alloys results in rapid tool wear when forming in the temperature range from 500 °C to 950 °C. Even when using temperature-resistant lubricants, the surface quality of the component and the process stability of the forming operations no longer meet the requirements after a short time. Consequently, the Fraunhofer IST develops anti-adhesive tool coatings for high-temperature forming of titanium funded by the Federal Ministry for Economic Affairs and Energy, with these coatings more efficient forming processes and an improved component quality should be achieved in the future.

**Titanium alloys**

Titanium alloys are characterized by a favorable ratio between weight and strength, good ductility, high thermal resilience, corrosion resistance, and biocompatibility. If used as a base material there is significant potential for development in a wide variety of application areas, such as aerospace, the chemical industry, and medical technology, as well as shipping.

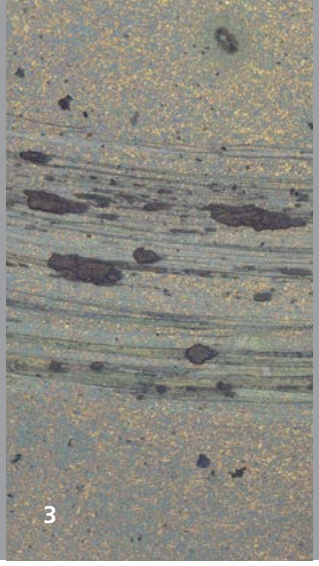
**Layer development**

The tungsten carbide tool coatings developed at the Fraunhofer IST (see Fig. 1) follow the principle for providing a self-lubricating boundary layer during the forming process. Application-oriented laboratory tests (see Fig. 2) prove that this effect causes a significant reduction in tool wear and of the associated friction forces in the contact with adhesive titanium materials (see Fig. 3 and the adjacent graphic). Other long-term tests substantiate a uniform layer performance even for stress durations in the range of industrial applications. These findings indicate that cost-intensive lubricants can be dispensed with and tool life and component quality can be increased. In addition to all major tool steels, temperature- resistant nickel-based materials can be coated with the aid of the PVD technology used. Depending on the tool material selected, operating temperatures of up to 950 °C can be achieved in different atmospheres, such as air, argon, or nitrogen.

**Industrial application**

Layer development occurred on PVD magnetron sputtering units in accordance with the industrial standard. Thus, the developed coatings can directly be transferred on real forming tools and used for industrial forming processes. The first real forming tests for solid forming and superplastic sheet metal forming of high-strength titanium alloys are currently being conducted with the project partners and should constitute the basis for final qualification of the film systems developed for industrial application.


Fraunhofer Institute for Surface Engineering and Thin Films IST | Bienroder Weg 54 E | 38108 Braunschweig | Germany



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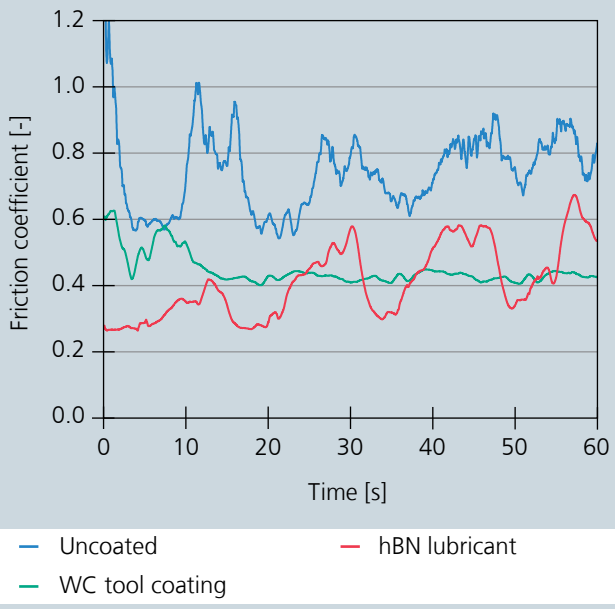
**The project**

The IGF project 18855BG of the Europäische Forschungsgesellschaft Dünne Schichten e.V. – EFDS, Gostritzer Str. 63, 01217 Dresden was funded via the AiF within the framework of the program for promoting Industrielle Gemeinschaftsforschung (IGF) of the Federal Ministry for Economic Affairs and Energy by decision of the German Bundestag.

Modifications of Inconel718 as tool material in comparison: Tribometer tests versus TiAl6V4 at 950 °C in Ar protective gas atmosphere.




**1** *SEM micrograph of the developed tungsten-carbide based tool coating.*

**2** *High-temperature tribometer with optional protective gas atmosphere for application-oriented layer development.*

**3-4** *Wear characteristics after application tests versus TiAl6V4 at 950°C under protective gas atmosphere. (3) Uncoated, with adhesion of titanium. (4) Coated, without any adhesion.*

# CONTACT

*Dipl. Wirt.-Ing. Tim Abraham*
*Phone +49 531 2155-655*
*tim.abraham@ist.fraunhofer.de*