ECOCOOL

Titan – A Material with Special Requirements

Image: DMG MORI

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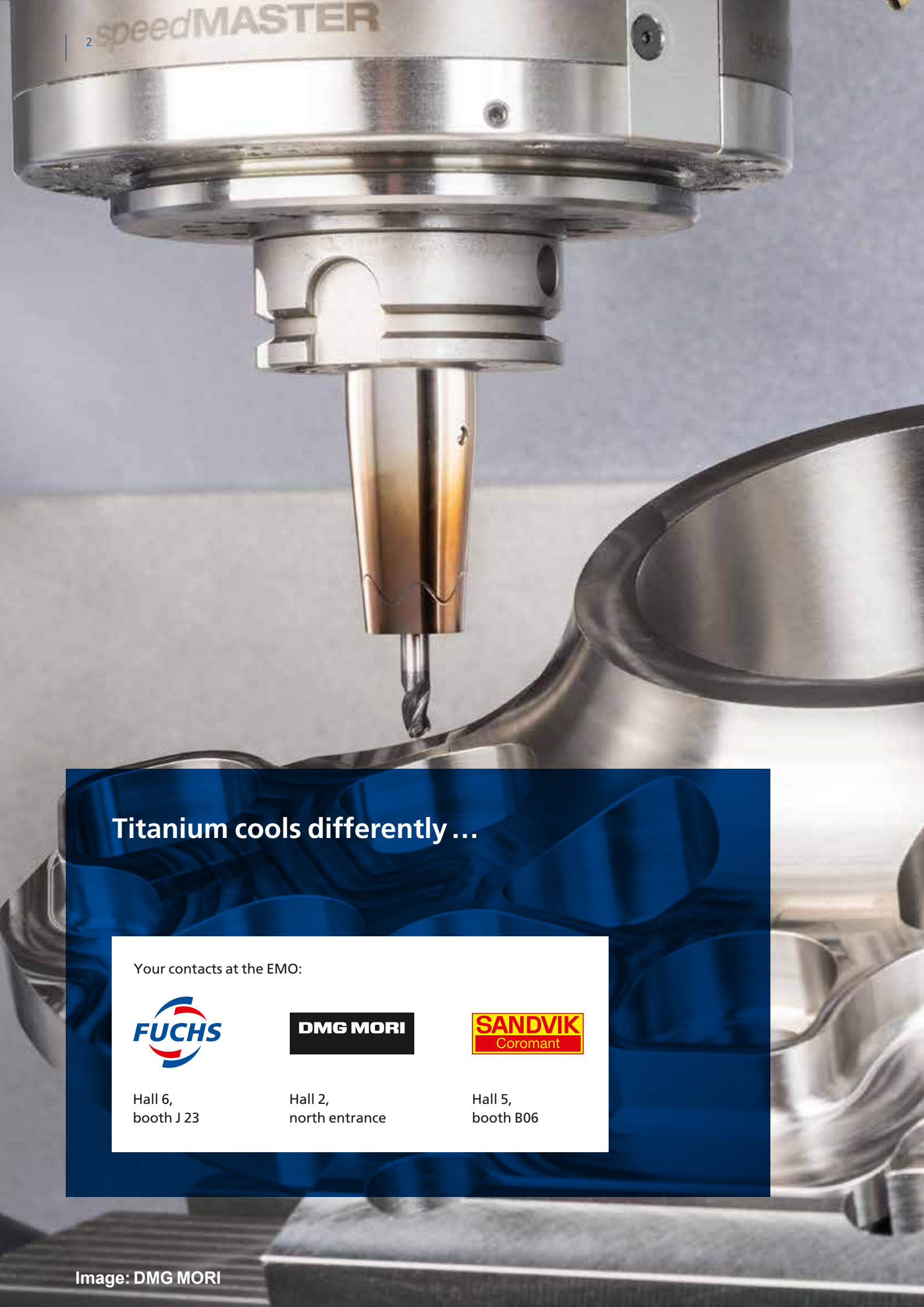

Titanium cools differently …

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DMG MORI
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SANDVIK Coromant
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Image: DMG MORI

Is the influence of metalworking fluids on the machining of titanium underestimated?

Difficult-to-machine materials such as titanium alloys and high-temperature, nickel-based alloys such as Inconel 718 pose significant challenges to the machining process. Titanium alloys are becoming increasingly popular in the aviation, automotive and medical engineering sectors. Their special properties make them especially suitable for reducing weight and downsizing. Nickel-based alloys are mostly used for components which are subject to high temperatures and/or stresses.

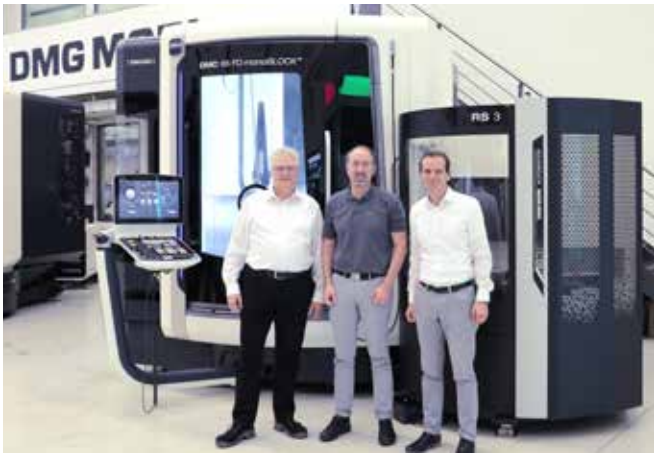
Particularly the milling of titanium puts significant thermal and mechanical strains on tools. Tool cutting edges are subject to extremely high abrasive wear. To counter this, a high-performance metalworking fluid must be used which provides, above all, good cooling properties and suitably high lubricity. Such a metalworking fluid can protect the tool and guarantee adequately tool life.

It is exactly this which a research project between the technology partners DMG MORI, SANDVIK COROMANT and FUCHS at the DMG MORI Aerospace Excellence Center in Pfronten/Germany examined. This involved wear tests on tools used for the milling of the titanium alloy Ti6Al4V with an uncoated, Ø10 mm, solid carbide milling tool on a 5-axis machining center (DMC 65 monoBLOCK®). The following three FUCHS metalworking fluids were used:

- **ECOCOOL A (8%) – The Benchmark MWF**
- **ECOCOOL B (10%) – Universal MWF**
- **ECOCOOL TNA-IDM (8%)**

All three of these metalworking fluids are based on completely different formulations. The products had to be tested in extreme conditions and to their limits to exactly determine their respective influence of the machining process.

Thanks to the expertise of company SANDVIK COROMANT in machining superalloys, it was possible to define optimum cutting parameters (vc = 80 m / min, fz = 0,0645 mm, ae = 1 mm, ap = 20 mm) to highlight the product differences in this test series. The cutting length had been defined in 120 m with a planned machining time of 120 minutes. The MWF supply was provided through both internal and external flooding. In order to check the reproducibility of the test, the trial with ECOCOOL TNA-IDM had been run twice. The results showed perfect reproducibility.



From left: Janos Jenei (FUCHS SCHMIERSTOFFE GMBH),
Marco Elkendorf and Michael Kirbach (both DECKEL MAHO Pforten GmbH)

ECCOCOOL A, ECOCOOL B and ECOCOOL TNA-IDM in comparison

Evaluation of the tool wear on the main cutting edges and at the corner radius

Even when the cutting edges are viewed from the side, the differences in the corner radius can be clearly seen (see Fig. 1 and 2).

Only the newly developed ECOCOOL TNA-IDM delivered a homogeneous cutting edge without chipping (see Fig. 3) and provided the lowest corner flank wear. Figure 4 demonstrates up to 86% wear reduction.

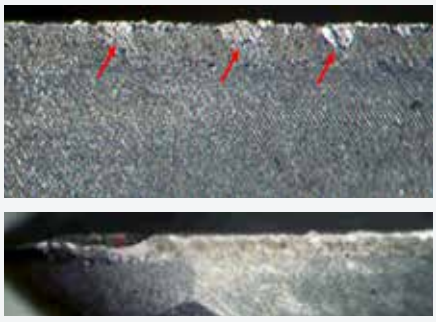


Fig. 1: ECOCOOL A

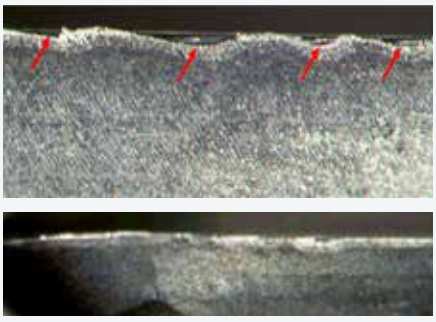


Fig. 2: ECOCOOL B

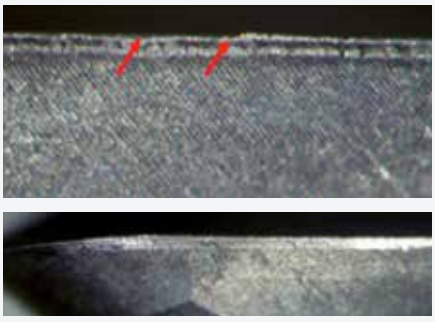


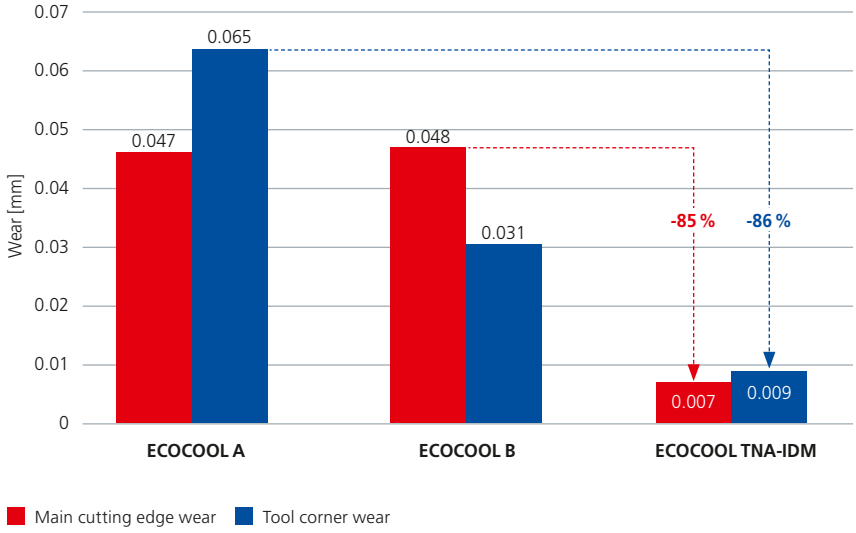
Fig. 3: ECOCOOL TNA-IDM

Images: SANDVIK Coromant

Wear measurement on the tool

Fig. 4: Tool wear results

On the main cutting edges ECOCOOL A and ECOCOOL B showed almost the same wear characteristics. However, wear on the corner radius was different (see Fig. 4).



ECCOCOOL A, ECOCOOL B and ECOCOOL TNA-IDM in comparison

Evaluation of the main cutting edge with an optical microscope

When the cutting edges of the tools were examined with an optical microscope, the tool was found to have sub-optimal cutting edges when ECOCOOL A and ECOCOOL B was used (see Fig. 5 and 6).

Only the product, ECOCOOL TNA-IDM showed homogeneous wear with no chipping (see Fig. 7).

Fig. 5: ECOCOOL A

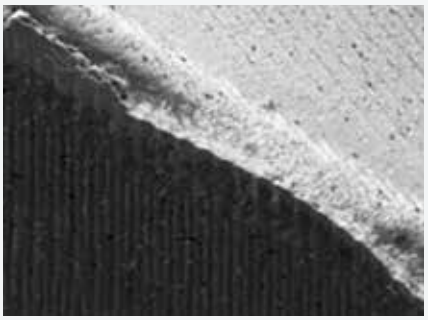


Fig. 6: ECOCOOL B

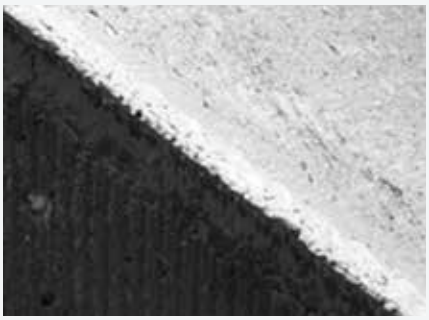


Fig. 7: ECOCOOL TNA-IDM

Images: SANDVIK Coromant

Summary of the test results

The purpose of the benchmark tests was to examine the influence of metalworking fluids on the milling of titanium under extreme conditions and to highlight the different performance of the products.

It was found that the previous benchmark product, ECOCOOL A delivers the necessary performance and the universal metalworking fluid ECOCOOL B can be used for occasional titanium machining but is not recommended for continuous operation. All three of the tested metalworking fluids have a significant impact on the machining process.

The best results were achieved with the use of the newly-developed ECOCOOL TNA-IDM. This high-performance metalworking fluid provides for stable and reliable machining, and also reduces the tool wear by up to 86 % compared to the other tested products.

DMC 65 monoBLOCK®

Note
The information contained in this product information is based on the experience and know-how of FUCHS SCHMIERSTOFFE GMBH in the development and manufacturing of lubricants and represents the current state-of-the-art. The performance of our products can be influenced by a series of factors, especially the specific use, the method of application, the operational environment, component pre-treatment, possible external contamination, etc. For this reason, universally-valid statements about the function of our products are not possible. Our products must not be used in aircrafts/spacecrafts or their components, unless such products are removed before the components are assembled into the aircraft/spacecraft. The information given in this product information represents general, non-binding guidelines. No warranty expressed or implied is given concerning the properties of the product or its suitability for any given application.

We therefore recommend that you consult a FUCHS SCHMIERSTOFFE GMBH application engineer to discuss application conditions and the performance criteria of the products before the product is used. It is the responsibility of the user to test the functional suitability of the product and to use it with the corresponding care.

Our products undergo continuous improvement. We therefore retain the right to change our product program, the products, and their manufacturing processes as well as all details of our product information sheets at any time and without warning, unless otherwise provided in customer-specific agreements. With the publication of this product information, all previous editions cease to be valid.

Images: DMG MORI

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