

High-performance alternative to traditional coatings for turbines

# Advanced sealing systems

In aerospace and power generation, aggressive targets have been set for reduced CO<sub>2</sub> and nitrogen oxide emissions from gas turbines. This poses huge challenges for improved engine sealing efficiencies through the correct use of abrasive tip material technology for turbine blades.

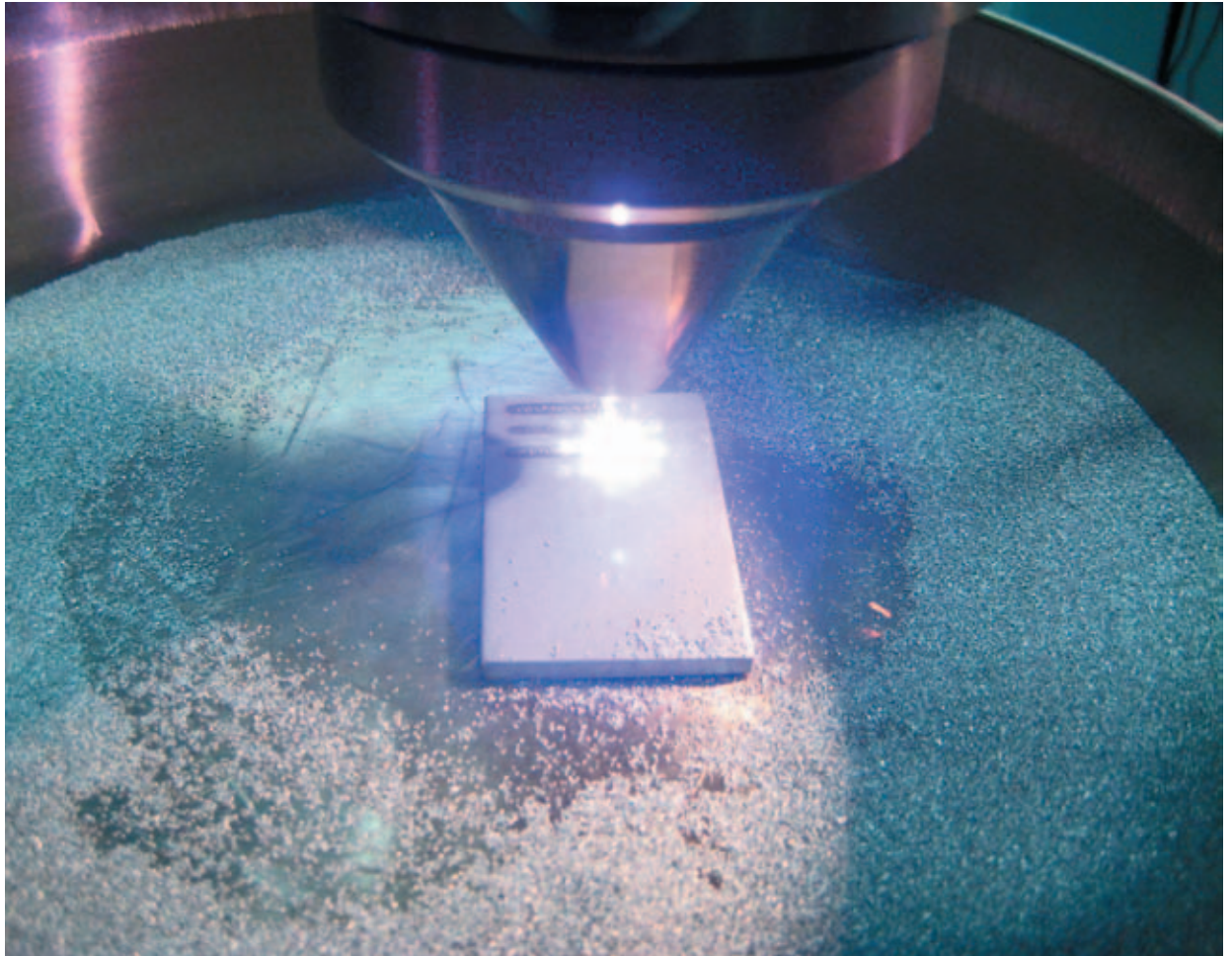
Current abrasive tip technology available in the market place is based primarily on the use of cubic boron nitride abrasive particles which are bonded to the blade tip in an oxidation and creep resistant matrix alloy, using proprietary alloy deposition technology. Cubic boron nitride is one of the hardest materials known, next to

diamond, and is an excellent abrasive material. However, it has one drawback; it oxidises rapidly when exposed to temperatures above 900°C and lasts less than 100 hours in the average turbine environment. Several alternative abrasives to cubic boron nitride were investigated in the EU funded ABRATIP program (Advanced abrasives and tip coatings

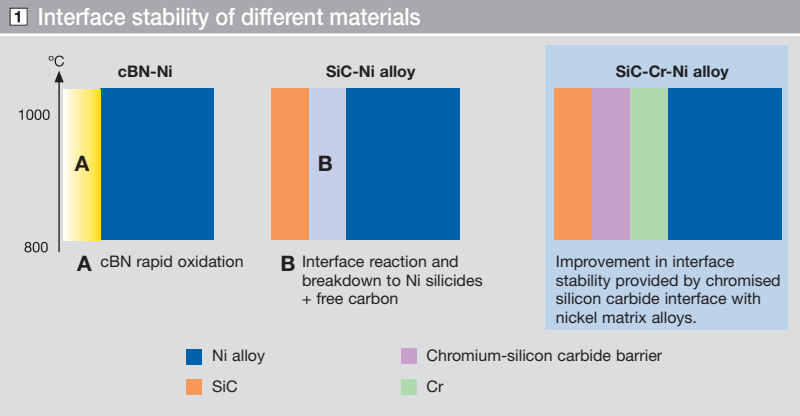
for gas turbines), with participation from Sulzer Innotec, Sulzer Metco and several aerospace OEMs.

## Reliable coating materials

The only candidate which exhibited equivalent cutting performance against ceramic abrasives was silicon carbide, which has excellent high temperature



Test sample in the laser deposition process.



oxidation resistance in comparison to cubic boron nitride [1]. However, it too has an inherent thermodynamic instability when brought in contact with turbine blade nickel based alloys. It will react with these alloys at high temperature and disintegrate. R&D activities continued to develop an effective silicon carbide abrasive solution that could be provided to OEMs for their blade tipping needs. Ceramic barrier coatings were applied to silicon carbide particles, but with only limited success as these tended to crack arising from thermal and elastic mismatch strains at sharp corners. Additional efforts were made to find a more compliant barrier coating.

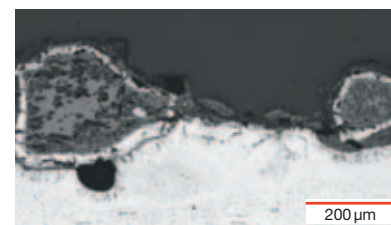
This is when the idea arose to use a reactive metal layer such as chromium to neutralise the reactivity of a silicon carbide surface. A more thermodynamic stable chromium-silicon-carbide barrier is formed when chromium is brought into contact with silicon carbide at elevated temperatures. A chromium barrier coating was then applied to silicon carbide abrasive particles successfully, which were then used in blade tipping trials.

**New market opportunities**

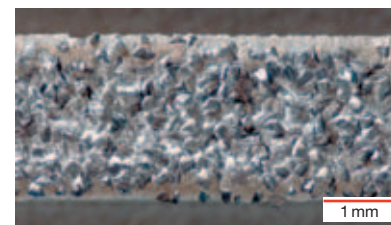
Sulzer Innotec embarked on feasibility trials to fix the chromised SiC onto standard turbine blade alloys using a dedi-

cated laser weld deposition process. Good results were obtained where the particles were successfully embedded without serious damage to particle integrity and the chromised layer near the laser beam heat input. Incursion tests using tipped blades against ceramic abrasable coatings, provided good results. The program has progressed far enough to be slowly moving out of the development stage and advancing toward market opportunities. A series of further development activities are now underway in partnership with Sulzer business units and their customers in aerospace, power and repair services.

Fiber laser facility at Sulzer Innotec Laser Surface Engineering in Winterthur.



Micrograph of laser deposited chromized SiC particles.



Current blade tipping technology: cubic boron nitride tipped blade appearance after incursion against a ceramic abrasable shroud.

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