Intrinsic cooling of high performance micro cutting tool

ICO-CUT, an Innosuisse project in collaboration with Eskenazi SA, Carouge

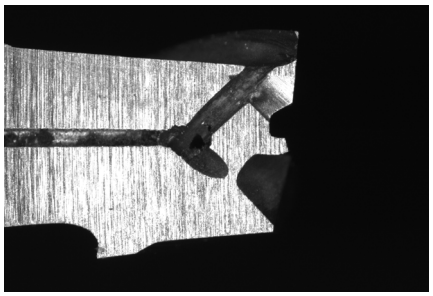
Georg Wälder

Brief description

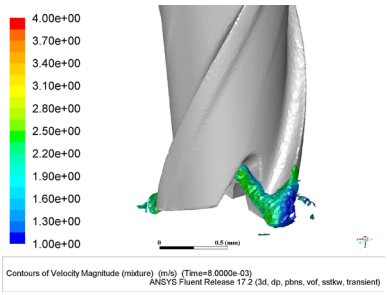
Eskenazi SA is a Geneva-based company specialized in the manufacture of cutting tools for precision mechanics. In collaboration with HEPIA and with the help of Innosuisse funding we have developed a high-performance hard metal micro-endmill with central cooling.
A pico-second laser type drilling was used to produce a precise hole and to avoid weakening the base material by thermal impacts. Cutting performance and tool life are significantly increased by this central lubrication compared to conventional external flushing.

Key points

A new production method has been developed to manufacture hard metal cutting tools with a diameter of the order of millimeters with a central hole for lubrication and cooling. Three lateral exhaust channels with diameters of the order of hundred micrometres are produced using a pico-second laser. The entire geometrical design of the tool is based on a complete CFD (Computational Fluid Dynamics) study. Thanks to this intrinsic cooling and production method, the tool lifetime is increased by a factor of 4 and the quality of the machining surface is improved compared to «conventional» tools.



CT-Scan of a laser drilled hole in a ø 1.0 mm hard metal milling cutter



Fluid simulation: cutting liquid at the cutting edge of fast turning milling tool

The cutting tools are the key element in any milling process; they determinate the process performance and the quality of the machined pieces. From environmental point of view and manufacturing cost, dry machining is better, but some mechanical pieces cannot be actually produced without lubrication fluid. In fact, the machining process needs to inject the cutting fluids as close as possible to the machining area between the tool and the work piece for chip evacuation, lubrication and cooling. Usually it is the case for small precise metallic pieces with high surface quality.

Today, the fluid is usually injected by adjustable nozzles, but new developments inject the fluid through the spindle, tool holder and finally through a central hole in the cutting tool. But this approach is limited to large diameter tools (> 6 mm). In addition, there is no individual lubrication of cutting edges of the tool, which would require several holes (or a central hole with several “outlets”).

For small diameter tools (< 3 mm) no solution is available to lubricate the cutting edges individually. The best technology uses intrinsic channels end at cone of the shank, well before the active cutting part. Here, lateral holes of a diameter of about 0.1-0.3 mm are required. Position, diameter, shape etc. of such holes need to be optimized by CFD and results to be validated by experimental tests.

Drilling such tiny holes at precise locations with well-defined directions represents several challenges. Due to its hardness it is difficult to machine the cutting tools by conventional methods. Electro-Discharge Machining (EDM) or conventional LASER could make the job, but thermal input may create micro cracks. These cracks will reduce the tool lifetime due to the forces created at high rotation speed of about 20’000 rpm and fluid pressure higher than 120 bars. To avoid these micro cracks, an ultrashort pulse LASER system was implemented which allows cold ablation and excellent surface finishing.

Project output:

- A publication “Laser drilling of micro-holes in cutting tools” was accepted and will be presented at the 20th CIRP conference on Electro Physical and Chemical Machining, ISEM 2020 in Zürich
- EU-Patent request No. 19175938.9 submitted on Mai 22, 2019
- Currently Eskenazi SA evaluates different commercial laser systems and plans to present the new products on tradeshows and will soon propose the new product range.