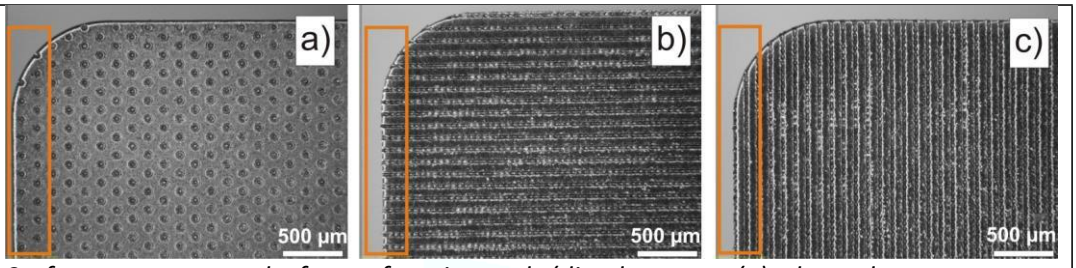
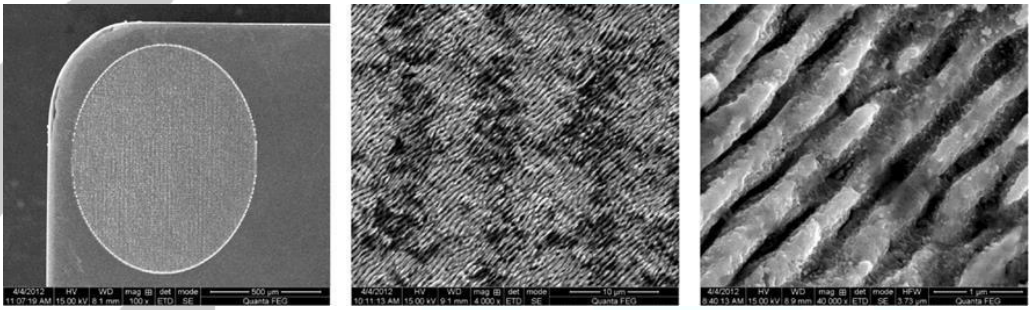
High-priority product: High Performance Cutting tools

Designation of multi-material multi-functional product:	*Higher performance cutting tools that combine the capabilities of ultra-hard materials and micro & nano texturing/structuring*
General description of product (3 – 4 sentences):	*A large proportion of cutting tools supplied worldwide involve coated cemented tungsten carbides, although there is also growing use of ultrahard materials such as ceramics and polycrystalline diamond, particularly for the machining of advanced, 'difficult to cut' workpiece materials (titanium alloys, nickel based superalloys, composites, sintered ceramics etc.). There is a wide range of tools with different cutting geometry for milling, turning and drilling operations. Cutting conditions aside, tool performance is dependent on several factors including material microstructure and composition (WC), coating properties and edge geometry/preparation, which includes elements such as chamfers, hones, chip breakers etc.*
Multi-materials needed/required:	Tungsten carbides, ceramics (PCBN, alumina, SiAlON etc.) and polycrystalline diamond (PCD) are usually used as substrate materials for producing high performance cutting tools. In particular, the multi-material aspects in their production are associated with designing and implementing combinations of functionally textured ultrahard substrate materials with multi-layer coatings and thus to create interface properties that can withstand the severe cutting conditions in machining 'difficult to cut' workpiece materials.
Multi-functionality needed/required:	*The modification of cutting tools' surfaces by incorporating either deterministic or random/stochastic micro-textures or features to improve the tribological characteristics and minimise/eliminate workpiece adhesion during machining.*
Expected improvement:	*Improvements in cutting tools' performance due to the reduction in built up edge/workpiece adhesion, improved retention of lubrication at the tool-chip interface and decrease in cutting forces and thus to achieve a more stable machining and extended tool life.*
Bottlenecks to overcome for reaching the expected improvement	*The development of subtractive-based techniques such as laser, electron beam and electrical discharge texturing to produce high performance cutting tools using ultrahard materials. It is important to stress that the subtractive processes have to be optimized to maintain the microstructure of ultrahard materials and thus in this way to retain their outstanding mechanical and thermal properties. In particular, it is necessary: (i) to identify parameters' domains for texturing various substrate cutting tool materials (e.g. cemented tungsten carbides, ceramics and PCD) while retaining their mechanical properties; (ii) to determine and correlate the effect of textured ultrahard surfaces and features on tool performance when machining advanced "difficult to cut" alloys; (iii) to design and implement flexible and optimized reconfigurable multi-axis texturing platforms for processing complex cutting tools with different designs including axisymmetric (rotating) tools (e.g. end mills, drills etc.); (iv) the development of inline model-based inspection techniques for characterizing the textured surfaces.*

And thus Functional requirements:	*Micro and nano texturing of 3D complex surfaces with feature sizes varying from 100 microns, e.g. dimples and slots, down to nano scale surface ripples for retaining hard lubricants on cutting tools.*
Technical sketch of product (if applicable):	



Surface textures on rake faces of cutting tools (dimple texture (a); channels perpendicular to cutting edge (b) and channels parallel to cutting edge (c))



Nano textured rake faces of cutting tools