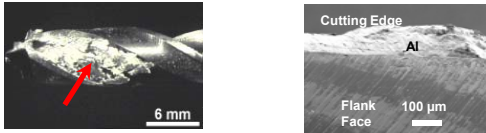


DLC TOOL AND DIE COATINGS

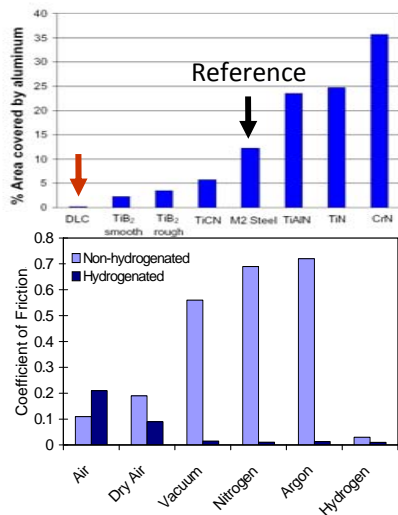
Drilling of Aluminum Alloys: Adhesion Problem



Elimination of metalworking fluids is desired due to environmental regulations and costs

In the absence of metalworking fluid aluminum chips stick to the tool surface (steel/carbide), causing failure

Ranking of Coatings

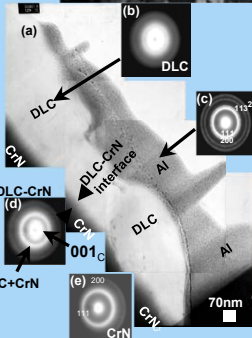
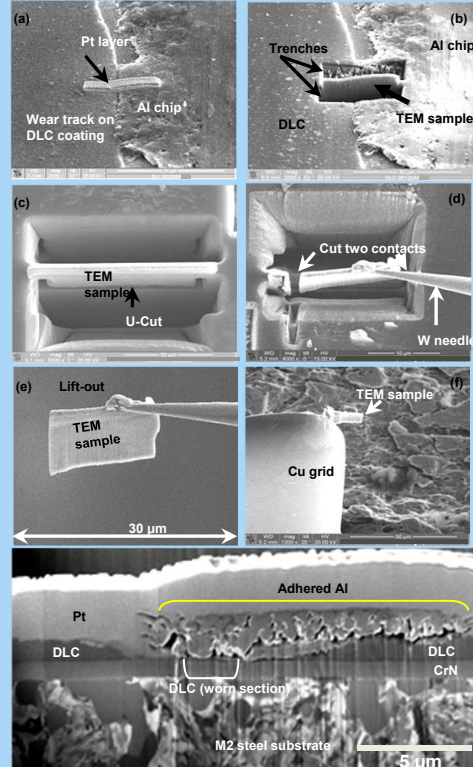


Diamond Like Carbon Coatings

Coating	H (GPa)	E (GPa)	Thickness (μm)	Ra (nm)	Deposition Method	H Content (at. %)
Non-hydrogenated DLC	16	148	2	18	Magnetron Sputtering	<2
Hydrogenated DLC	10	114	1	11	Sputtering & CVD	40

Focused Ion Beam (FIB) – Transmission Electron Microscope (TEM) Studies

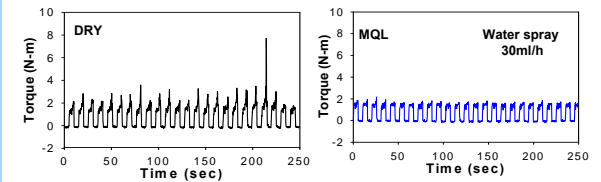
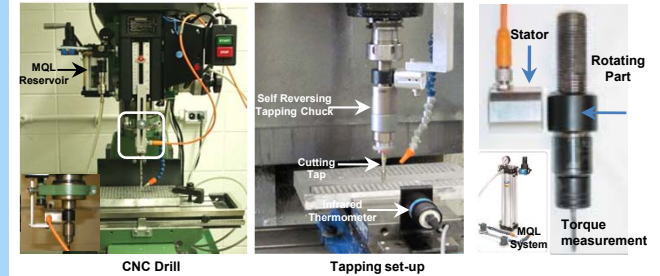
Steps of the procedure used in making cross-sectional TEM samples using the FIB lift-out method



Cross-sectional FIB images of microstructure of the substrate and the DLC coating.

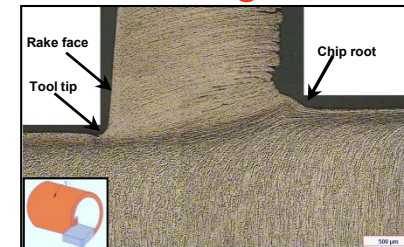
TEM micrograph showing a section of DLC coating with aluminum adhered on its surface.

Experimental Drilling Tests

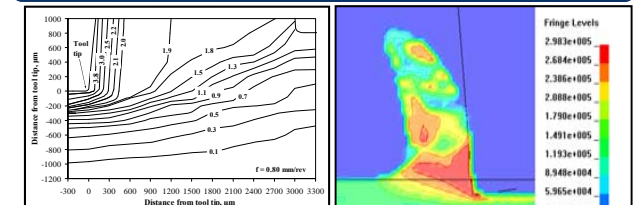


Lower and stable torque response during MQL drilling of 319 Al (non-hydrogenated DLC coated drill).

Numerical Modeling of Machining



Optical cross-sectional microstructure of workpiece 1100 Al ahead of the tool tip



Strain distribution (kPa) in the workpiece of 1100 Al ahead of tool tip