Tool wear in turning of pure aluminum and drilling of carbon fiber reinforced plastics (CFRP)/titanium (Ti) stacks was investigated due to their importance in modern manufacturing. Although pure aluminum is a ductile metal while CFRP contains brittle carbon fibers, there exist also few important similarities which impact tool wear. For instance, neither work material contains inclusions harder than the tool material. Thus, in both cases, the abrasive wear mechanism, which comes from the hard inclusion abrading the tool surface, cannot explain the tool wear. Thus, selecting a tool material solely based on higher hardness does not always provide a longer tool life. This study presents a new explanation for tool wear with these work materials based on our experiments.

Fine and coarse grain tungsten carbide-cobalt tools were used for turning commercially pure aluminum. Two types of tool wear were observed on both grades of tools. The first type of wear was due to carbide grain pullout from the surface by adhesion. The abrasion by the pull-out grains was the second type of wear observed. Larger flank wear was observed on the fine grain carbide than the coarse grain carbide despite the higher hardness of the fine grain carbide. The increase in tool wear was explained by the higher probability of a finer carbide grain being pulled out of the matrix compared to a coarser carbide grain.

The evolution of Built up edge (BUE) in aluminum turning was studied. It was shown that the BUE decreased after the cobalt binder on the surface of the tool was removed by wear. The influence of oxidation in the formation of BUE is also discussed.

In the CFRP/Ti stack drilling study, three types of experiments were carried out: CFRP-only drilling, titanium-only drilling and combined CFRP/Ti stack drilling. The tool wear were investigated on uncoated WC-Co drills, diamond coated drills, AlMgB₁₄ (BAM) coated drills and nano-composite coated drills. There were two significant findings in the CFRP-only drilling study. First, edge rounding was found to be the main tool wear mode for all types of drills. A hypothesis was developed to explain the cause of edge rounding wear in CFRP machining. In metal machining, the wear on the cutting edge is normally prevented by a stagnation zone. However, the fracture-based chip formation in cutting CFRP prevented the formation of a stagnation zone. Rapid wear rounds off the cutting edge. Second, the tool wear measurements in the CFRP drilling experiment did not match the abrasive wear resistance of the drills. Instead, the results from tribo-meter tests correlated well with the tool wear in the CFRP drilling. Therefore, it is believed that tribo-meter testing can be used to rank suitable tool materials for CFRP drilling without carrying out extensive drilling experiments.

In Ti-only drilling, edge chipping and coating flake off were the dominant wear types. The diamond coating, which is effective in drilling CFRP-only, flaked off due to Coefficient of Thermal Expansion (CTE) mismatch and graphitization.

Finally, it was found that CFRP/Ti stack drilling was mainly a combination of the gradual wear in CFRP drilling and the coating flaking off and edge chipping in Ti drilling. Study of the individual work materials provided understanding of the combined wear mechanisms. This allows for future improvement of tools used in the machining of CFRP/Ti stack drilling.