Investigation on diamond tool wear in ultraprecision machining of polymers

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Abstract

Polymers are increasingly used in various applications of optic technologies such as bi-focal microscope lenses, contact lenses and intraocular lenses. Polymeric lense arrays for lighting and environmental detection in automotive applications gain importance. However, the diamond tool wear at cutting polymers is 5 to 10 times higher compared to cutting copper with the same parameters. Therefore, research on diamond tool wear mechanisms, optimised turning parameters and development of a method to reduce tool wear are essential to decrease the machined surface roughness as well as economical efficiency in ultra-precision machining of polymeric materials. Chemical reaction between the diamond and the polymer as well as tribo-electric charge during machining processes are the dominant factors for diamond tool wear.

Continuous and interrupted face turning experiments are conducted in this study to investigate the effects from seperation of the diamond tool and workpiece. In these investigations the polymers polycarbonate (PC), polysulfone (PSU) and polymethylmethacrylate (PMMA) are examined. In addition, diamond tool wear in different humidity environments is studied.

Results of the investigations show high chemical tool wear. Furthermore, tool wear increases significantly, when the cutting process is interrupted. A reduction of tool wear was observed under ambient conditions with high air humidity. As a result of the study, the chemical-physical correlations that contribute to tool wear in ultraprecision polymer machining are presented.