Suppression Mechanism of Diamond Tool Wear in Ultrasonic Vibration Cutting

Satoru Fukumori[1, a)], Fumihiro Itoigawa[1, b)], Satoru Maegawa[1, c)] and Eiji Shamoto[2, d)]

[1]Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya-shi, Aichi 466-8555, Japan
[2]Nagoya University, Furo-cho, Chikusa-ku, Nagoya-shi, Aichi 464-8601, Japan

[a)] 30413170@stn.nitech.ac.jp
[b)] itoigawa.fumihiro@nitech.ac.jp
[c)] maegawa.satoru@nitech.ac.jp
[d)] shamoto@nagoya-u.jp

Abstract. It has been known that the use of "ultrasonic elliptical vibration cutting", in which synchronized two-directional vibrations applied to the cutting edge in the plane including the cutting direction and the chip flow direction, is effective to reduce the diffusion wear of diamond tools in cutting of ferrous materials. However, the mechanism of the suppression of diamond tool wear under the ultrasonic elliptical vibration cutting has not been clarified. Although a lot of analytical models have been proposed so far, they have not reached a definitive understanding. From this background, in this study, some experimental studies were performed to understand the above mechanism. Specially, we investigated the effect of adsorption films, which is formed by the adsorption of atmospheric gasses on the newly-formed chip surface, on the wear suppression mechanism. As work materials, stainless steel, pure iron, carbon steel and pure molybdenum were prepared. By incorporation a cutting tester into the vacuum chamber, the ultrasonic vibration cutting experiments with these work materials were performed under both atmosphere and vacuum conditions. After the cutting experiments, diamond tool wear was observed by using the optical microscope and SEM (Scanning Electron Microscope). Furthermore, the adhesive materials on the cutting chip surface were investigated through TOF-SIMS (Time-of-Flight Secondary Ion Mass Spectrometry) analysis. From the results of these experiments, it was found that existence of atmosphere gas and the reactivity of the worked materials and carbon of diamond are important factors determining the wear rate of the diamond tool under the ultrasonic elliptical vibration cutting.