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Authors: Xiuqing Hao, Wei Cui, Liang Li, Hanlong Li, Aqib Mashood Khan, Ning He

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Cutting performance of textured polycrystalline diamond tools with composite lyophilic/lyophobic wettabilities

Xiuqing Hao[1, 2*], Wei Cui[1], Liang Li[1], Hanlong Li[1], Aqib Mashood Khan[1], Ning He[1]

1 Jiangsu Key Laboratory of Precision and Micro-Manufacturing Technology, College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics & Astronautics, Nanjing 210016, China

2 State Key Laboratory of Tribology, Tsinghua University, Beijing 100084, China

(*Correspondence: Xiuqing Hao, College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics & Astronautics, 29 Yudao Street, Nanjing, 210016, China; Tel: 86-25-84893567; E-mail: xqhao@nuaa.edu.cn)

Abstract: This paper develops a new technology to improve the anti-friction performance of cutting tools by constructing textured surface with composite lyophilic/lyophobic wettabilities and this method is applied to polycrystalline diamond (PCD) tools. Lyophobic micro/nano structures and lyophilic grooves were successively fabricated on the tool surface by a pulsed fiber laser using different processing parameters. Then the influence of un-textured PCD tools, microgrooved tools and textured tools with lyophilic/lyophobic wettabilities on cutting performance and tool wear were investigated during turning of Ti6Al4V titanium alloy bar under minimum quantity lubrication (MQL) environment. The results indicated that textured PCD tools with lyophilic/lyophobic wettabilities reduced the cutting force, average friction coefficient and cutting tool wear in comparison of un-textured tools and microgrooved tools. Furthermore, the anti-friction mechanism of textured tools with lyophilic/lyophobic wettabilities was discussed from the aspects of drag reduction and the regulation of movement of cutting liquid to the impact tool-chip interface. This new technology provides a new way for textured tools to further enhance cutting performance and mitigate tool wear.

Keywords: Anti-friction; Lyophilic/lyophobic texture; PCD cutting tools; Titanium alloy