Tool Coatings and Their Influence on the Length of Steady-State Wear Region for Micro End Mills

CATEGORY OR KEYWORD
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INTRODUCTION

Increasing miniaturization has increased demand for machining highly accurate small parts. Micro-milling presents a viable method for series machining parts such as miniature heat exchangers or fuel injectors. Micro-tool wear is considerably more difficult to monitor than that of larger tools, and the tools often fail due to chipping or shaft failure. This leads to unpredictable costs and inefficient processes.

Conversely, macro end mill wear is well characterized, and the typical wear curve well understood. The aim of this work is to elongate the steady state region of the wear curve for micro-end-mills, as this is the practical life of the tool. Coatings can be applied to achieve this, improving wear rates and cutting performance.

ABSTRACT

Tool wear during straight-slot machining with 500µm micro-end-mills was examined. The length of the steady-state region was used to evaluate the ability of various new coatings to extend the working tool life. Several coatings were investigated for their effect on this steady state region when cutting brass, titanium and Hastelloy.

Wear mechanisms have been considered and the relationship between these and the shape of the wear curve examined. The results demonstrate that it is possible to engineer micro-end-mills to increase their steady state life, as with macro-end-mills, and this is further improved by the understanding of the wear mechanisms on the scale of micro-mills. This elongation leads to longer tool life. The relative predictability in the steady state region allows tool paths to be modified to account for changing tool geometry.

Overall, this work presents the first attempt to manipulate the wear curve for micro-end-mills. Whilst existing studies have considered the effect of coatings on the overall life of the tool, this study highlights the importance of developing a detailed understanding of the wear mechanisms taking place over tool life in optimizing coating design.

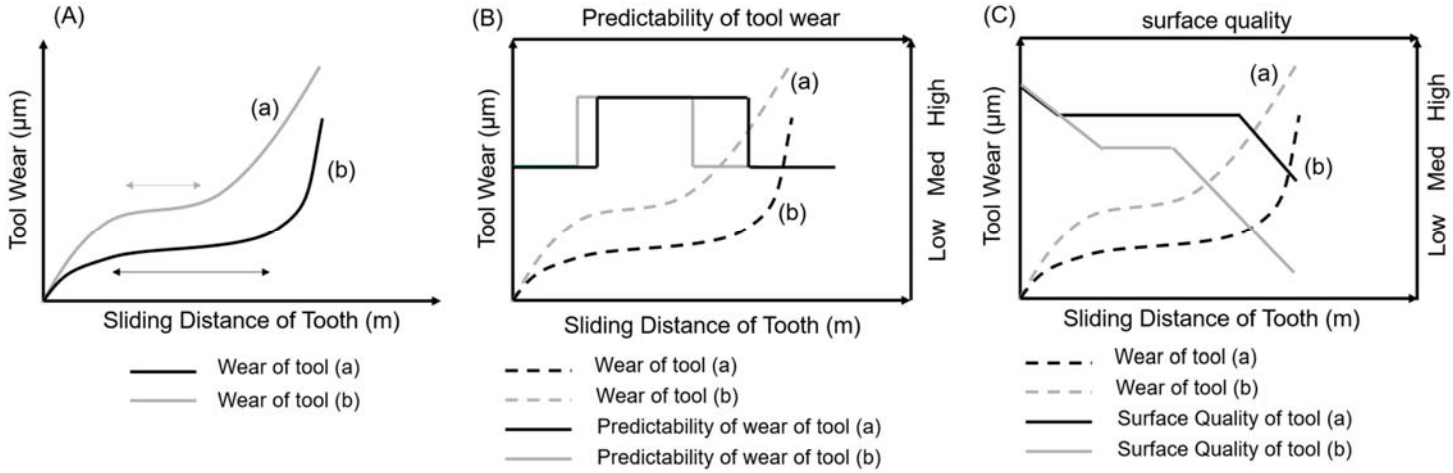

Figure 1. A simplified version of the effects that the region of the wear curve the tool is in has on tool diameter predictions.

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