

# Fundamental Theory of Non-uniform Residual Tool Marks in Ultra-Precision Diamond End-Flycutting

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**Abstract:** Residual tool marks (RTMs) in diamond cutting critically affect the quality of machined nanosurfaces. Traditionally, researchers assume that planar machining results a flat due to the uniformity of RTMs. In this study, we verify the phenomenon of non-uniform RTMs in diamond end-flycutting and elucidate the factors contributing to the non-uniformity. We developed an evolutionary model to trace the impact of position-induced RTMs on final surface characteristics, which was validated through experiments. Our findings challenge the conventional assumption of planar machining when using end-flycutting method, revealing that the machined surface actually resemble a symmetrical curved surface—higher at the center and lower at the edges. This curved surface introduces a new positional controlling parameter not only for nanosurface machining, but also for microstructure fabricating in diamond end-flycutting. This study documents non-uniform surfaces in ultra-precision end-flycutting and first introduce the position parameter, providing guidance for researchers to re-evaluate the reliability and precision of their experimental results.

**KEYWORDS:** Diamond cutting; End-flycutting; Residual tool mark; Modelling; Microstructure