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Surface roughness analysis in turning titanium alloy under MQL and cryogenic coolants

[Jurnal Tribologi](#) • Article • 2026[Sulaiman, Mohd Amri](#)^a ; [Salleh, Mohd Shukor](#)^a;[Khairussaleh, Nor Khairusshima Muhammad](#)^b; [Ibrahim, Ikhwan Nasir](#)^a; [Tomadi, Siti Haryani](#)^b;
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Abstract

Titanium alloys are valued for their high strength-to-weight ratio and thermal stability, making them essential in aerospace and medical applications. However, their poor thermal conductivity and rapid tool wear pose significant challenges to machinability. This study investigates the effects of minimum quantity lubrication (MQL) and cryogenic CO₂ cooling on surface roughness during the turning of titanium alloy (Ti-6Al-4V ELI). Turning operational were conducted on a CNC lathe using uncoated carbide inserts. The cutting parameters were set as follows: cutting speeds of 120, 170, and 220 m/min; feed rates of 0.10, 0.15, and 0.20 mm/rev; and depths of cut of 0.4, 0.5, and 0.6 mm. Surface roughness was measured with a portable Mitutoyo SJ-301 tester over a 20 mm cutting length at three different locations along the machined surface. Response surface methodology (RSM) was applied to analyze the data, assess model accuracy, and identify significant factors. Results showed that MQL consistently produced better surface quality, with feed rate identified as the most

influential factor; lower feed rates yielded smoother finishes. These findings emphasize the role of advanced cooling techniques in enhancing machining performance, particularly for aerospace and biomedical applications where high precision is critical. © 2026, Malaysian Tribology Society (Mytribos). All rights reserved.

Author keywords

Cryogenic; MQL; Surface roughness; Ti-6Al-4V ELI; Turning process

Funding details

Details about financial support for research, including funding sources and grant numbers as provided in academic publications.

Funding sponsor	Funding number	Acronym
Universiti Teknikal Malaysia Melaka See opportunities by UTeM ↗		UTeM

Funding text

The authors thankfully acknowledged the financial support and laboratories works provided by the Universiti Teknikal Malaysia Melaka (UTeM) for this research.

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