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## Effects of DLC/TiAlN-coated die on friction and wear in sheet-metal forming under dry and oil-lubricated conditions: Experimental and numerical studies

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### WEAR

Volume: 438

Article Number: 203040

DOI: 10.1016/j.wear.2019.203040

Published: NOV 15 2019

Document Type: Article

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### Abstract

Experimental and numerical analyses were conducted to explore the influence of DLC/TiAlN-coated die surfaces in sheet-metal forming under dry and oil-lubricated conditions. In this study, ironing and deep-drawing experiments were performed to determine the potential of the DLC/TiAlN coating in the sheet forming of stainless steels under different tribological conditions. The performance and physical properties of the DLC/TiAlN-coated die surface were obtained through load, surface roughness, and wear measurements as well as hardness and microstructure examination. The experimental results indicated that the DLC/TiAlN coating strongly resists galling under dry friction and thin film lubrication conditions that reduces the friction and forming load. The presence of a thin oil film reduces the sliding-originated surface tensile stresses of the DLC/TiAlN coating, improving the wear resistance of the die surface even at high temperatures and high contact pressures. Thermomechanical numerical analysis supported the experimental results, which confirmed that the lubricant discharged the heat generated in the die-workpiece contact region to reduce the friction and forming load. With the DLC/TiAlN coating, the plain mineral oil with no extreme pressure additives can function as effective as chlorinated paraffin oil for protecting the die surface, thus extending the die service life.

### Keywords

**Author Keywords:** Sliding wear; Sliding friction; Galling; Steel; Carbon-based coatings; Other manufacturing processes

**KeyWords Plus:** PVD COATINGS; BEHAVIOR; PERFORMANCE; TIALN; AEROSPACE; ALLOYS

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Det Frie Forskningsrad (DFF)		DFF-4005-00130
Taiho Kogyo Tribology Research Foundation Japan		9008-00015
Short-term Grant UniMAP		9009-00059
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ELSEVIER SCIENCE SA, PO BOX 564, 1001 LAUSANNE, SWITZERLAND

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