

# SURFACE FUNCTIONALIZATION OF DRILL TOOLS WITH NANO COATED MICRO-SCALE RESERVOIRS

## IITM Technology Available for Licensing

### Problem Statement

- The real challenge pertaining to high aspect ratio micro/macro drilling of super alloys is the rapid increase in chip evacuation force due to the chip clogging phenomenon occurring at higher drilling depths. The clogged chips will further impede the reachability of cutting fluid at the machining zone leading to the tool temperature buildup and catastrophic tool failure.
- Technology development for generating micro scale textures on the intricate free form surfaces of flute and margin side of twist drill bits.
- Research focus on improving sustainable machining strategies in terms of tool life enhancement and machined surface quality, with minimal energy utilization, and environmental pollution caused by conventional cutting fluids and their disposal.
- Inventors developed **nano-coated micro-scale reservoirs on the intricate free form surface of drill tools to reduce sliding friction at cutting interfaces**, thereby minimizing energy consumption and enabling sustainable machining especially for super alloys with minimal environmental impact.

### Intellectual Property

- IITM IDF Ref. 1432
- IN 465242 - Patent Granted

### TRL (Technology Readiness Level)

TRL - 4: Technology validated in lab scale.

### Technology Category/ Market

**Category - Advanced Machining Tools**

**Applications-** Aerospace, Automotive

**Industry-** Industrial Machinery, Aerospace, Automotive Manufacturing.

**Market -** Global Drilling Tools market size is estimated to be worth USD 6525 million in 2022 and is forecast to a readjusted size of USD 8184 million by 2028 with a **CAGR of 3.8%**.

### Research Lab

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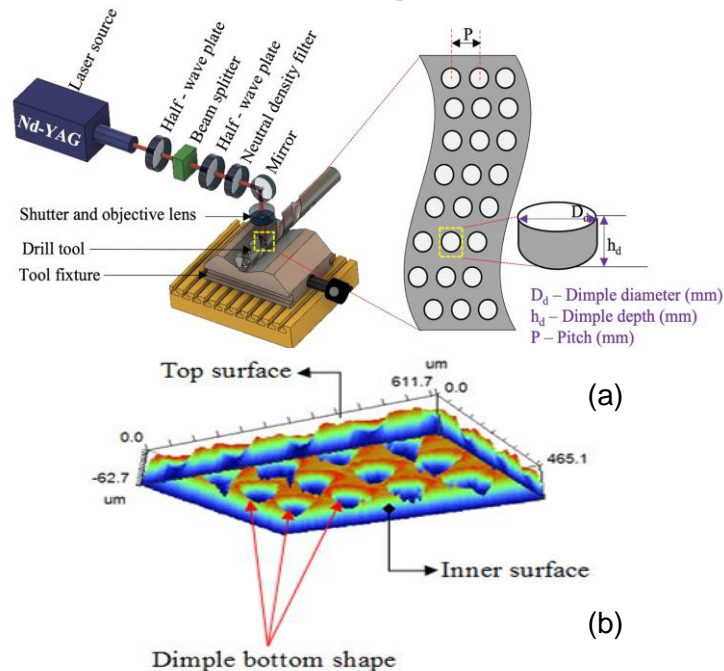


FIG. 1(a). Nd-YAG Pulsed Laser Micromachining setup for Surface functionalization (b). 3D profile of micro dimples.

### Technology

- Functionalization of Free form surfaces:** Design and development of drill bits with circular micro dimples of diameter 90  $\mu\text{m}$  and depth 60  $\mu\text{m}$  nano-coated with titanium aluminum nitride on the intricate free form surface of flute and margin side for reducing cutting forces and enhancing wear resistance, thermal stability, and surface finish.
- Integration with MQL System:** Integration of nano-coated textured tools with Minimum Quantity Lubrication (MQL) system for sustainable machining of super alloys, minimizing energy loss due to frictional heating and reducing cutting fluid consumption.
- High Aspect Ratio Machining Efficiency Enhancement:** Utilization of micro-scale reservoirs coupled with MQL system at flute and margin sides as hydrodynamic lubrication regime to reduce energy wastage due to sliding friction during drilling of titanium alloys at high aspect ratios, leading to improved tribological characteristics and productivity.

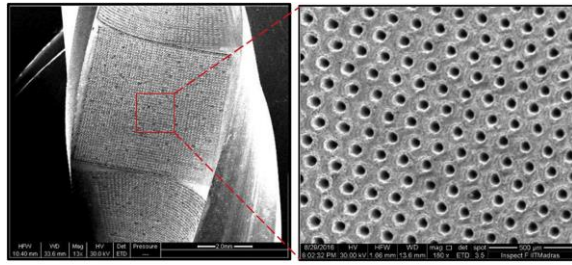
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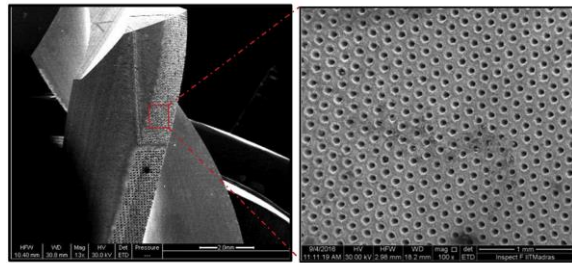
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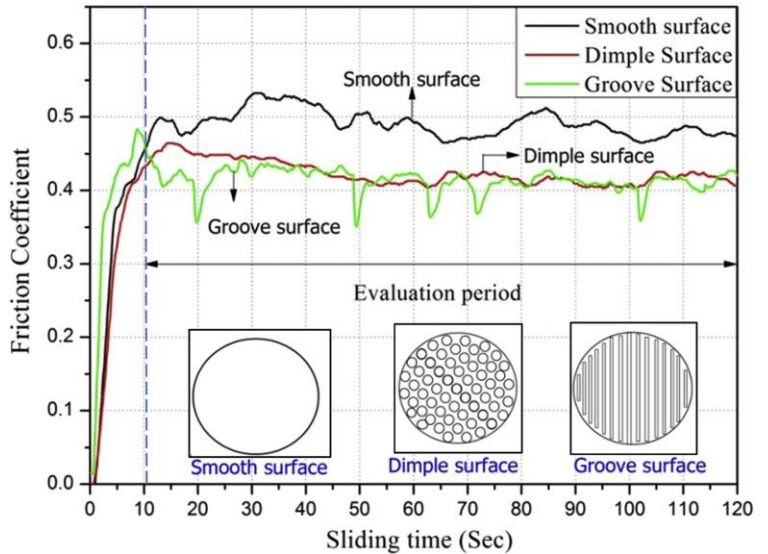
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(a) Flute side



(b) Margin side



(c)

FIG. 2 (a). SEM image of micro textures at flute side, (b). SEM image of micro textures at margin side (c). Tribological characteristics of the micro textured surfaces under different textures sliding conditions

### Key Features / Value Proposition

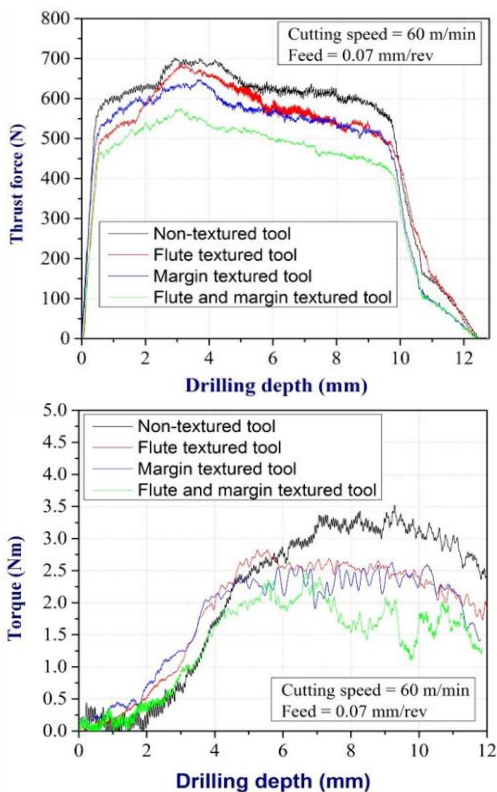


FIG. 3. Comparison of drilling forces measured under different cutting conditions

#### Sustainable Machining Solutions

- Offering environmentally friendly drilling solutions with nano-coated textured tools and MQL system.

#### Technology for surface functionalization

- Providing uniform surface functionalization on intricate controlled free form components for improving the tribological characteristics.

#### Efficient high aspect ratio drilling

- Providing drill tool with micro/nano-textures and wear-resistant nano-coatings for efficient high aspect ratio drilling with improved wear resistance and surface finish.

#### Reduced Energy Consumption

- Minimizing energy loss due to frictional heating during metal cutting with integrated nano-coated micro-reservoirs and MQL systems

#### Optimized Machining of Super Alloys

- Facilitating efficient sustainable drilling strategy for lower thermal conductive super alloys like titanium and Nickel with improved productivity.

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