IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

A TURNING CUTTER DESIGN FOR ENHANCING THE EFFICIENCY OF CUTTING PROCESSES

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Parasitic mechanisms** like **chatter, tool wear, and plowing** can **hinder metal cutting processes** by **generating higher forces and energy consumption.**
- These mechanisms have been studied individually, but collectively affect the cutting process.
- Solutions often involve using **auxiliary components or mathematical calculations** to determine favorable conditions for cutting, **which are expensive and cumbersome.**
- The inventions describe **composite micro-texture super hard tools** and **semi-finish machining indexable turning tool** blades for nickel-based superalloy semi-finish machining, featuring a tool body and micro-texture tool bit and the art of tool and cutter designs is intricate and complex.
- There is a **need for a simple, benign solution** based on metal cutting physics.

TECHNOLOGY CATEGORY/ MARKET

Technology: Turning cutting tool design
Category: Assistive, Test Equipment & Design Manufacturing
Industry: Cutting tool design & Manufacturing Industry
Application: Machining operations.
Market: The global market size was estimated to be worth **USD 25200 million in 2022** and is forecast to a readjusted size of **USD 35540 million by 2028** with a **CAGR of 5.9%** during the forecast period **2022-2028**

INTELLECTUAL PROPERTY

IITM IDF Ref. 2345
Patent No: IN 540842

TRL (Technology Readiness Level)

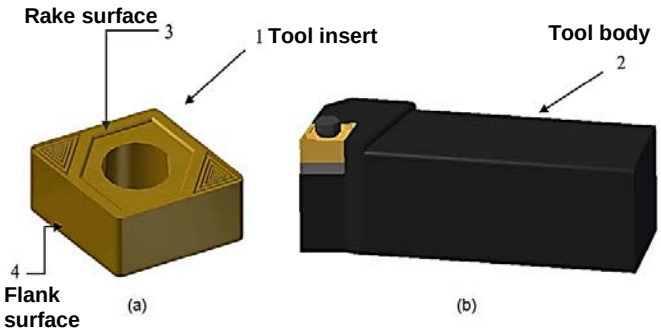
TRL- 4, Experimentally validated in Lab;

Research Lab

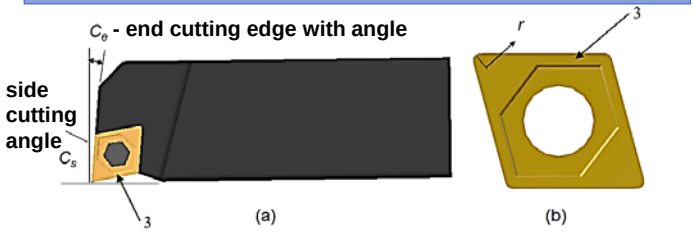
Prof. Balakrishna C Rao,
Dept. of Engineering Design

TECHNOLOGY

3D CATIA model

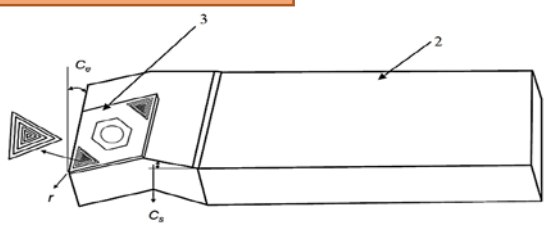


- **(a) the surface textured cutting insert with triangular micro-grooves**
- **(b) the proposed turning cutter assembled with an insert shim and the insert.**



- **(a) Side and end cutting edge angle values seen on the top view of the 3D cutter model**
- **(b) bottom view of the 3D insert**

wireframe 3D model



- **Side and end cutting edge angle values, nose radius, and triangular micro-grooves marked on the wireframe 3D model of the proposed turning cutter**

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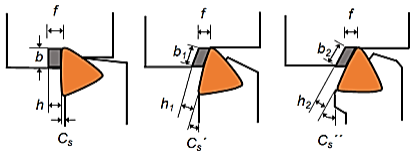
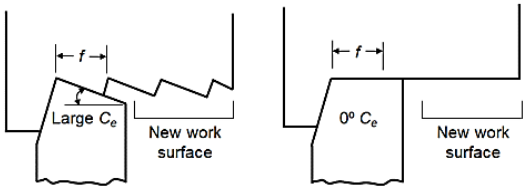
Variation of chip width and thickness with Cs at a constant feed



Effect of Ce on the theoretical finish of machined surface for a single-point cutting tool at equal feed



Key Features / Value Proposition

Nose Radius (r) = 0.1 to 0.2 mm

- Sharp tool mitigates chatter by alleviating **cross-coupling effect**
- Reduced tool strength due to sharp nose is compensated by thicker insert body
- **Increased surface roughness controlled by MC effect**, low Ce and moderate Cs

Side Cutting Edge Angle (Cs) = 20 °

- Chatter control by **nullifying interference effect and controlling regenerative effect**
- Improved tool life owing to cutting forces being distributed onto a larger area
- Improved surface quality through **reduced chatter and vibration**.

End Cutting Edge Angle (Ce) = 10°

- **Back forces** kept in check to **avoid chatter**
- Sufficient clearance between tool and workpiece **reduces tool wear**
- **Low Ce is congenial for a better machined surface**

Surface Texturing

- Reduced cutting forces and cutting temperature due to smaller tool-chip contact contributes to chatter control
- Improved tool life due to reduced friction and improved heat dissipation by solid lubricant
- **Negative impact on surface quality compensated by proposed tool geometry features of Cs and Ce + MC effect**

Mechanochemical Effect

- Sinuous flow, a material deformation mode, generates large forces and thick chips.
- Prestraining the annealed work material can reduce strain and cutting forces by 70%.
- **Applying a Dykem ink layer can suppress sinuous flow, reducing cutting forces and improving surface quality**.

Advantages

- A cutter with **lower cutting forces and energy consumption**.
- Alleviate parasitic mechanisms like chatter, tool wear, and plowing.
- Having **sustainability** in manufacturing.
- Novel Turning Cutter Tool Design.
- Features **smaller nose radius, designated cutting edge angles, and surface texture on insert rake face**.
- Incorporates geometry features and mechanochemical effect to reduce cutting forces and energy.
- **Improved surface quality, increases tool life, and increases throughput.**
- Suitable for **multipoint milling and precision cutters**, facilitating sustainable machining operations.

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