



### Industrial Consultancy & Sponsored Research (IC&SR)

#### A METHOD OF PRODUCING FOILS USING LSEM FIXTURE

#### IITM Technology Available for Licensing

##### PROBLEM STATEMENT

- **Nanocrystalline (grain size < 100 nm) and ultra-fine-grained (grain size between 100 nm and 1000 nm) materials** are characterized by **superior mechanical properties** vis-a-vis their conventional counterparts.
- **Large strain extrusion machining (LSEM)** is a severe plastic deformation process used to **produce nano crystalline and ultra-fine-grained chips or shavings** due to its enhanced mechanical properties, including **hardness, strength, ductility, fracture toughness**, fatigue life, and wear resistance.
- **Furthermore, this process** has the **potential to be a low-cost alternative** for the production of **fine grained chips in the form of sheets, foils, and rods** especially from high strength metals and alloys.

##### TECHNOLOGY CATEGORY MARKET

**Technology:** Producing foils using LSEM fixture

**Category:** Advance Material & Manufacturing

**Industry:** Manufacturing

**Application:** Automotive, Machine tool

**Market:** The global market size was **estimated at USD 92.78 billion in 2023** and is anticipated to grow at a **CAGR of 5.8% from 2024 to 2030**.

##### INTELLECTUAL PROPERTY

IITM IDF Ref. 1386

Patent No: IN 365294

##### TRL (Technology Readiness Level)

TRL-4, Experimentally validated in Lab;

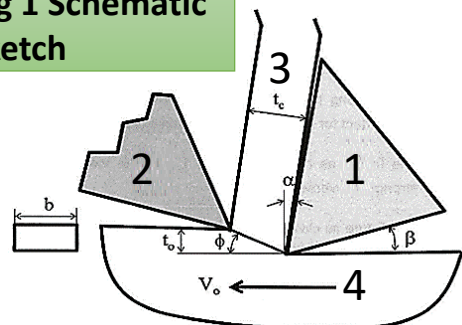
##### Research Lab

**Prof. Murthy H S N**, Dept. of Aerospace Engineering &  
**Prof. Balakrishna C Rao**, Dept. of Engineering Design

##### TECHNOLOGY

- 1 A fixture for holding a cutting tool to provide constraint during large strain extrusion machining (LSEM) with higher chip compression ratio to produce fine-grained foils, characterized by:-
- 2 A Ti-6Al-4V plate with a strong transverse texture which is suitably textured by the cold-rolling process to suppress shear localization in the extrusion-machined foils.
- 3 A fixture with a wedge-shaped slot provided to facilitate the flow of foils, and
- 4 A cutting tool positioned in the fixture with a groove type restricted contact for performing large strain extrusion machining.

**Fig 1 Schematic sketch**



Numerals	Definition
1	CONSTRAINT
2	CUTTING TOOL
3	FOIL
4	WORKPIECE

##### CONTACT US

**Dr. Dara Ajay, Head TTO**  
Technology Transfer Office,  
IPM Cell- IC&SR, IIT Madras

**IITM TTO Website:**  
<https://ipm.icsr.in/ipm/>

**Email:** [headtto-icsr@icsrpis.iitm.ac.in](mailto:headtto-icsr@icsrpis.iitm.ac.in)  
[tto-mktg@icsrpis.iitm.ac.in](mailto:tto-mktg@icsrpis.iitm.ac.in)

**Phone:** +91-44-2257 9756/ 9719

Fig 2 shows a Variation of shear strain ( $\gamma$ ) with chip compression ratio ( $\lambda$ ) For different rake angles ( $\alpha$ ).

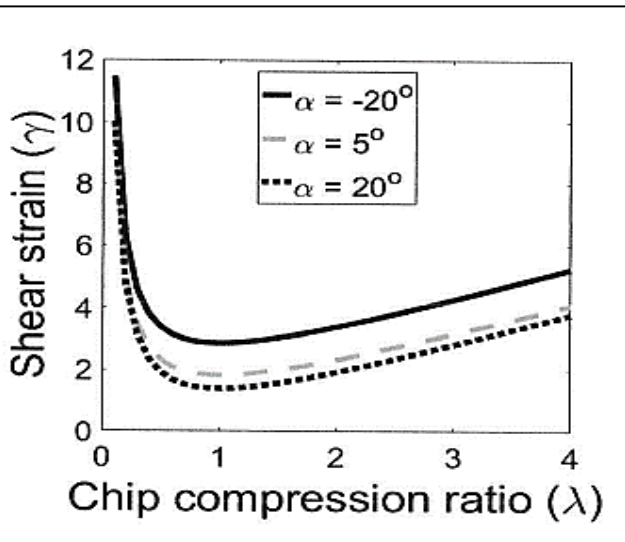
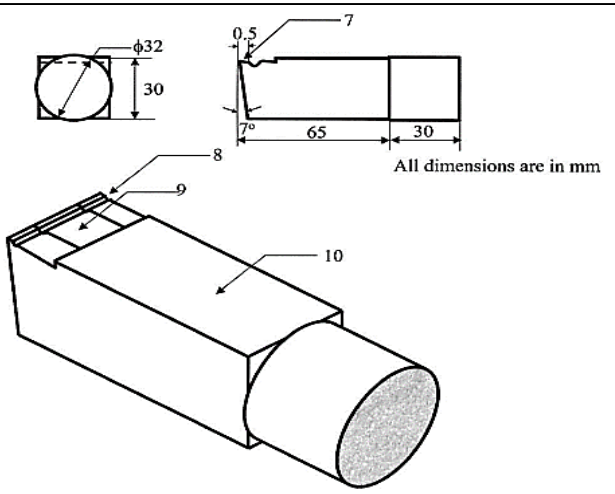
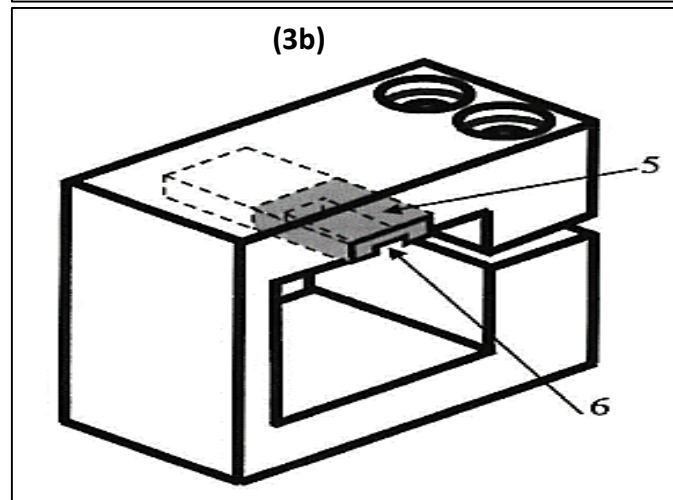
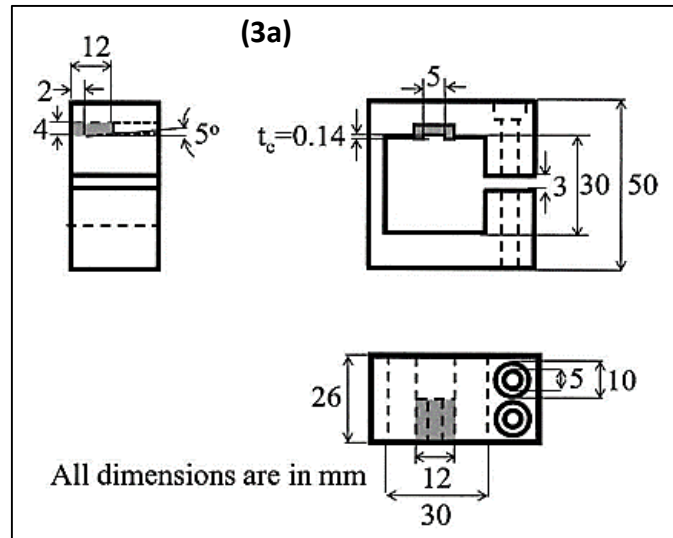


Fig 4 shows a groove type restricted-contact tool with 5° rake angle and 0.5mm restricted-contact length



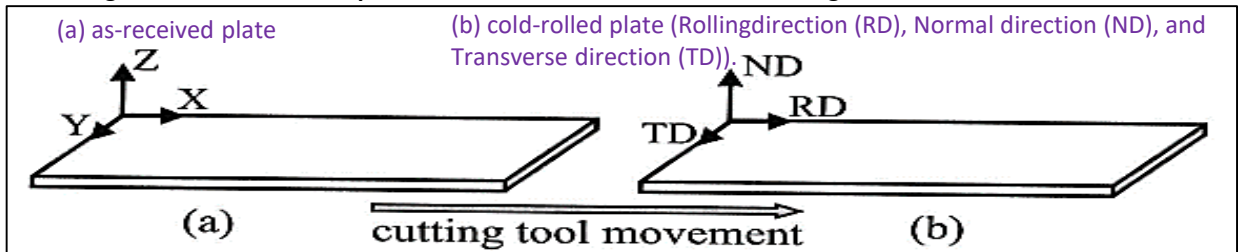
7- 5° RAKE ANGLE WITH 0.5 mm RESTRICTED CONTACT LENGTH, 8- GROOVE, 9-TUNGSTEN CARBIDE INSERT, 10-EN8 TOOL HOLDER

Fig 3 a & 3b shows a Large strain extrusion machining fixture with a chip compression ratio ( $\lambda$ ) Of 1.4



5 - Tungsten carbide block brazed to the LSEM fixture  
6- Groove provided for chip flow

Fig 5a & 5b shows a Sample reference frame and direction of cutting tool movement



### CONTACT US

Dr. Dara Ajay, Head TTO  
Technology Transfer Office,  
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:  
<https://ipm.icsr.in/ipm/>

Email: [headtto-icsr@icsrpis.iitm.ac.in](mailto:headtto-icsr@icsrpis.iitm.ac.in)  
[tto-mktg@icsrpis.iitm.ac.in](mailto:tto-mktg@icsrpis.iitm.ac.in)

Phone: +91-44-2257 9756/ 9719

Fig 6 shows a recalculated (0002) pole figures of (a) as-received and (b) as received 47% cold-rolled bulk samples.

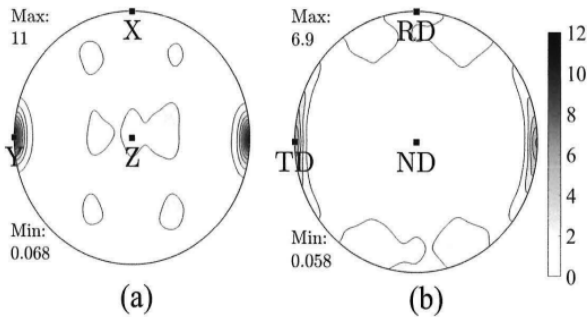


Fig 7 shows a optical micrograph of the (a) as-received, (b) as-received 47% cold-rolled bulk samples

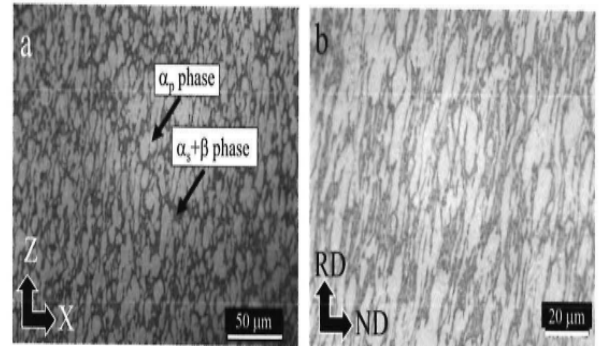
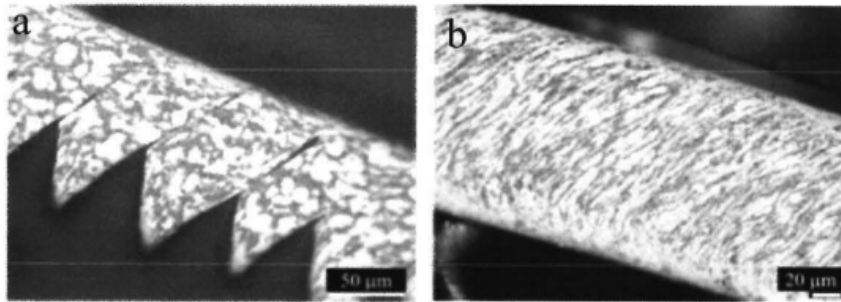


Fig 8 shows a optical micrograph of foil from (a) as-received bulk, (b) as received 47% cold-rolled bulk during the extrusion-machining process



### Key Features / Value Proposition

#### "Suppressing Shear Localization in Ti-6Al-4V"

- Modification of fixture in Ti-6Al-4V via cold-rolling.
- Extrusion-machining of textured plates using higher compression ratio.
- Fine-grained continuous foils with increased hardness.
- Reduced friction during extrusion-machining.

#### Fixture Features:

- Chip compression ratio: 1.4
- EN8 tool holder with brazed tungsten carbide insert.
- The fixture was employed to produce low cost ultra fine grained Ti-6Al-4V foils from its bulk.
- Having design and fabrication of a fixture which acts as a constraint during large strain extrusion machining process

#### CONTACT US

Dr. Dara Ajay, Head TTO  
Technology Transfer Office,  
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:  
<https://ipm.icsr.in/ipm/>

Email: [headtto-icsr@icsrpis.iitm.ac.in](mailto:headtto-icsr@icsrpis.iitm.ac.in)  
[tto-mktg@icsrpis.iitm.ac.in](mailto:tto-mktg@icsrpis.iitm.ac.in)

Phone: +91-44-2257 9756/ 9719