

CMTI being a premier institute in manufacturing research and developments is working on the field of Precision Engineering for over 25 years. This centre also focuses on ultra precision machine tool developments and aggregates (like spindle, slides, etc) of machine tools for ingenious and indigenous developments for the country. This centre has developed multiple ingenious product developments to the level of TRL 5- 7.

## UPM Product & Technology Developments

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### UPM Product & Technology Developments

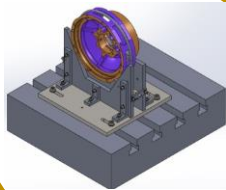


## Precision Machine Tools & Aggregates Group

## Engineering Services

This group also offers Engineering & Consultancy Services for Precision Product developments & facility for Testing.

### Engineering Services

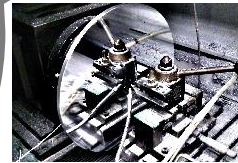


## Machining Services

Ultra Precision Machining, Fabrication & Polishing Services are offered on the following Processes,

- Single Point Diamond Turning.
- Abrasive Flow Finishing.
- Micro 3D Printing.

### Machining Services



# Nano Manufacturing Technology Centre



Nanoshape T250 is a **Highly Stiff and Ultra Precise Turning machine**, developed by CMTI, equipped with state of the art technologies for producing **non-ferrous, ferrous and IR material components** with optical quality surface finish. The machine accuracies are in the order of nanometers.

### Salient Features

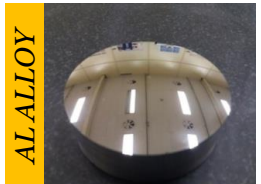
- Highly Stiff Hydrostatic Oil Bearing Slides
- Ultra Precise Aerostatic Spindle
- Natural Granite Bed with Vibration Isolation System and active leveling
- Independent Slide configuration
- Open Architecture Motion Controller with Adaptive Control Technology, intelligent diagnostics and error compensation
- Integrated chiller for Thermally stable slides and spindle

### Applications

- Lenses for Night Vision & Thermography
- Metal Mirrors for Space & Astronomical Systems
- Ultra precision Hard Turning
- Mirrors for Electro-optical systems
- Dies and Molds for LED Photonics & Mobile Camera lenses
- Molds and lens for Ophthalmic, Intro-ocular & Contact lenses for Medical Sectors
- Ultra Precision Mechanical Components

Work piece accuracies	
AL 6061 T6 alloy, 75mm dia convex (ROC-250mm)	Surface Roughness (Ra) < 2 nm, Form Accuracy (P-V) < 0.2 micron

Machine Features	Specifications
Number of Axis	3 Axis (X & Z, C-Axis)
Maximum Workpiece Size	Diameter 250 mm , length 150 mm
Spindle Running Accuracy	≤ 25nm
Work Holding Spindle Max. speed	8,000 RPM
Positional accuracy	≤ 0.6μm
Straightness of Slides	≤ 0.3μm



AL ALLOY

Ra < 1.4nm



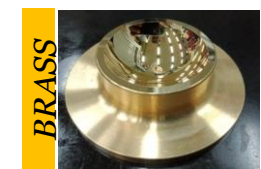
HARDENED STEEL

Ra < 14nm



GERMANIUM

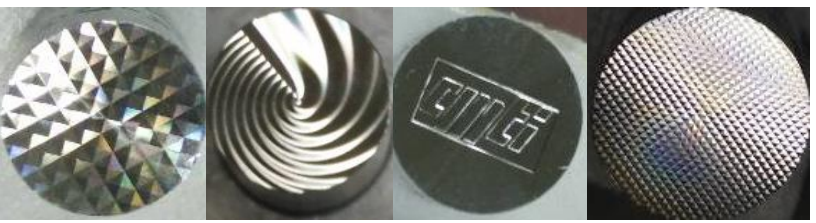
Ra < 0.9nm



BRASS

Ra < 2nm

# Diamond turning-Machining Services



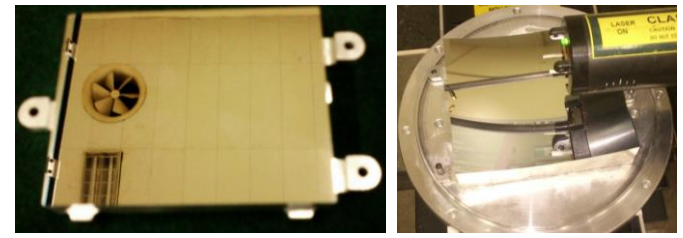
*FTS machined components*



*Bearing component Machining*



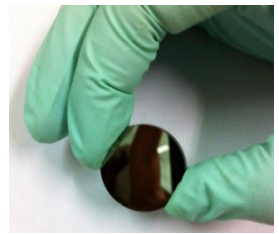
*Micro-lens array for Photonic Applications*



*Space Mirrors*



*Reflector Plate – Semi-conductor application*

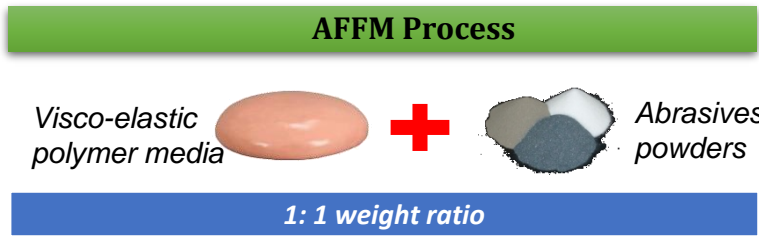


*Germanium Lens  
(Infra-red application)*

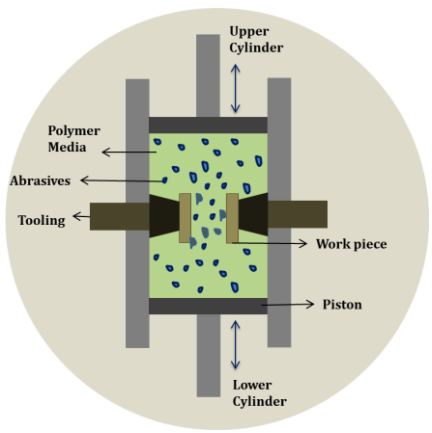
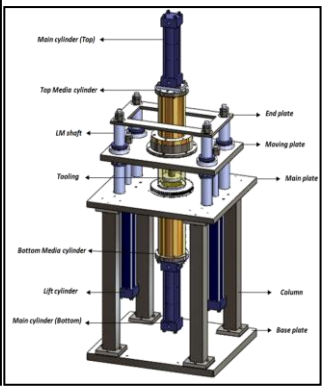
# Nano Manufacturing Technology Centre

## ABRASIVE FLOW FINISHING MACHINE **AFFM -150D**

The Abrasive Flow Machining is a metal finishing process that involves extruding an Abrasive filled semisolid media through a work piece passage.



Parameter	Value
Maximum height of the component	10 to 300 mm
Hydraulic pressure range	15 to 100 bar
Media cylinder bore diameter	150 mm
Media piston stroke	250 mm
Controller	PLC & HMI based



**Capabilities**

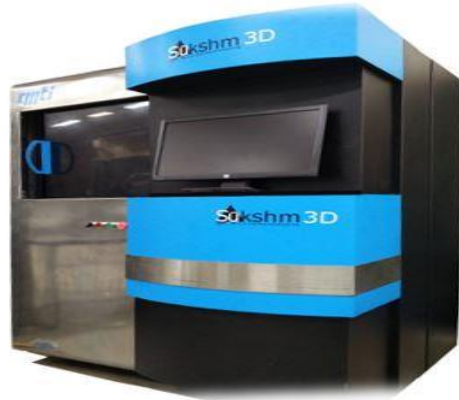
- ❖ Finishing/deburr ID and OD of components.
- ❖ Radiusing of sharp edges.
- ❖ Finishes inaccessible areas & complex internal passages.
- ❖ Rotary motion to improve the performance.
- ❖ Temperature control of abrasive laden polymer media.
- ❖ Simultaneous processing of multiple passages.

Indigenously developed AFFM-150D at CMTI

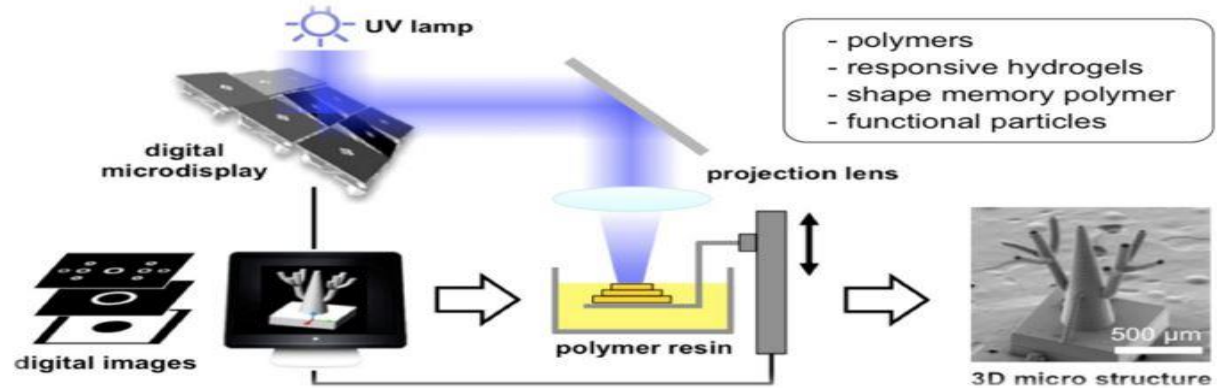
# SUKSHM 3D - Micro 3D Fabrication System

## Principle

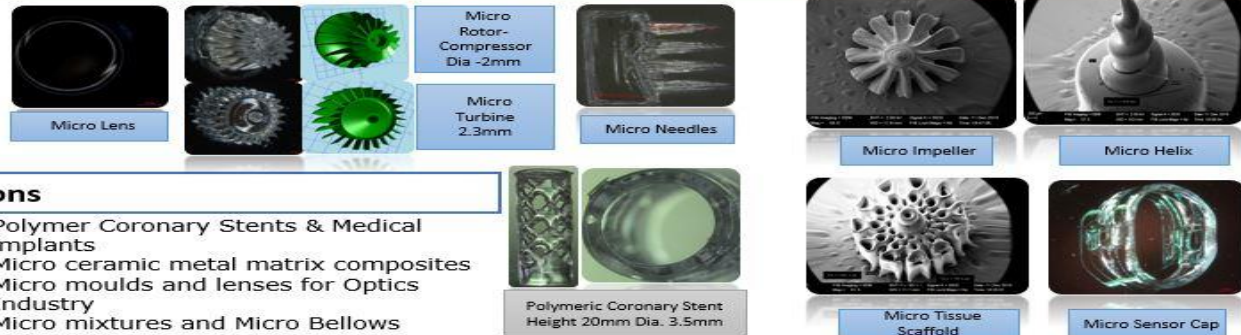
Projection micro-stereolithography (PμSL) adapts 3D printing technology for micro-fabrication. Digital micro display technology provides dynamic stereolithography masks that work as a virtual photo mask. This technique allows for rapid photo polymerization of an entire layer with a flash of UV illumination at micro-scale resolution. The mask can control individual pixel light intensity, allowing control of material properties of the fabricated structure with desired spatial distribution.



## Projection Micro stereolithography Technique

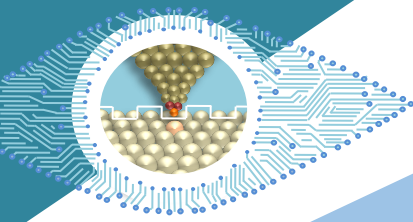


## Fabricated Micro 3D Components



## Applications

- Prototyping of CAD models, metal castings
- Design and fabrication of complex 3D Micro components
- MEMS Sensors and Actuators
- Scaffold fabrication for tissue engineering
- Polymer Coronary Stents & Medical implants
- Micro ceramic metal matrix composites
- Micro moulds and lenses for Optics Industry
- Micro mixtures and Micro Bellows



# NanoAvalok<sup>STM</sup>

(Explore the fascination of Quantum world....)

## STM-600

CMTI in collaboration with i2n Technologies has developed a portable Scanning Tunneling Microscope, capable of imaging sample at atomic resolution. The technology primarily address the need of academic institutions, R&D labs and Industries, with relatively affordable STM setup that could be utilized in nanotechnology research.

The compact portable system which potentially acquires the surface topography with quick, reliable and repeatable measurements

### Features

- ❖ Easy to use
- ❖ Atomic resolution
- ❖ Portable and compact
- ❖ Table top system
- ❖ Quick exchange of tip and sample
- ❖ In-built vibration & acoustic enclosure



**Technical Specification**

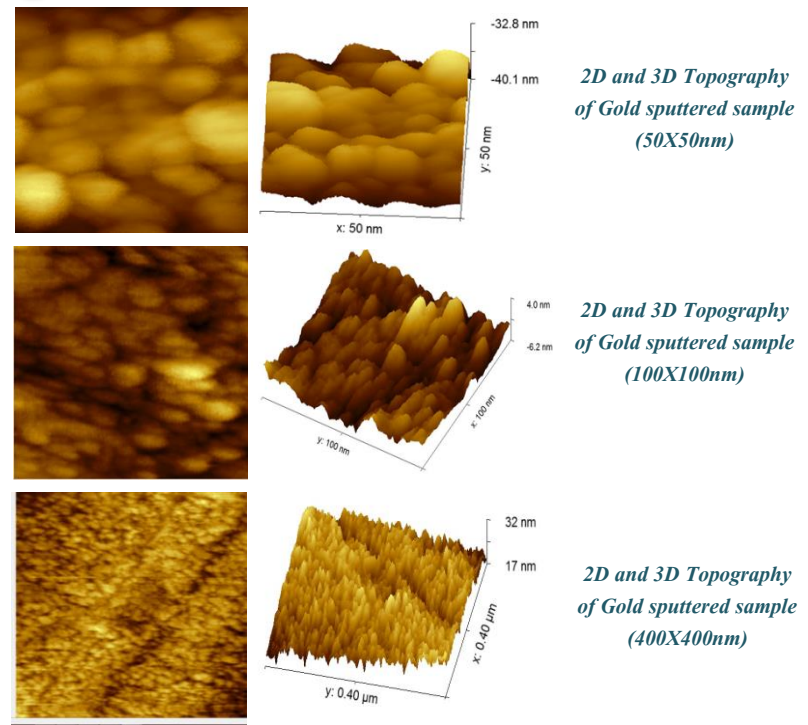
Piezo Tube Scanner	Range: XY – 600 nm, Z - 200 nm Resolution XY – 0.01 nm, Z - 0.003 nm (16 bit electronics)
Tip/Sample Coarse Movement	Tip Coarse positioning: Y (Vertical) direction Range: 13 mm, Resolution of 10µm Sample Coarse Positioning (X&Z direction) Range: 13 mm, Resolution of 0.5µm in X & 22nm Z (Motorised)
Electronics	Tunnelling Current preamp: Gain: 100 mV/Na, Noise: 0.02 nArms Sample Bias: ± 10 V
Software	GUI (Graphical User Interface) based user friendly software
Vibration isolation	Above 6 Hz, isolation efficiency above 80%
Acoustic isolation	Noise attenuation above 20 dBA

**Applications**

- ❖ Surface morphology studies
- ❖ Molecular bonding studies
- ❖ Spectroscopy studies (I-V Characteristics)
- ❖ Collective electron behaviour studies

❖ Nano/metric scale manipulation

**STM Gallery**



The gallery displays three sets of STM images for gold sputtered samples. Each set includes a 2D color map and a 3D topographic plot. The first set shows a 50x50 nm area with a height range of -32.8 nm to -40.1 nm. The second set shows a 100x100 nm area with a height range of 4.0 nm to -6.2 nm. The third set shows a 400x400 nm area with a height range of 32 nm to 17 nm.

*2D and 3D Topography of Gold sputtered sample (50X50nm)*

*2D and 3D Topography of Gold sputtered sample (100X100nm)*

*2D and 3D Topography of Gold sputtered sample (400X400nm)*

# Nano Manufacturing Technology Centre

## Ultra Stiff Ultra Precision Hydrostatic Slide



## NANO Slideway HS 200

### Salient Features

- Hydrostatic oil Bearing with theoretical infinite lifetime
- True motion, zero stick-slip, zero backlash & Maximum positioning accuracy
- High stiffness for Heavy loads & excellent geometric performance
- High Dampening effect from oil film for vibration from machining process
- Thermally stable, with heat dissipation by oil & additional water cooling
- Direct drive with Integrated Linear motor with low cogging force
- Ultra precision Linear Glass Scale for position feedback

### Applications

Nano Slideway HS 200 (Ultra stiff ultra precision hydrostatic slide) is ideally suited for development of

- ultra precision turning machines,
- ultra precision milling machines,
- ultra precision boring,
- Jig boring & grinding machines.

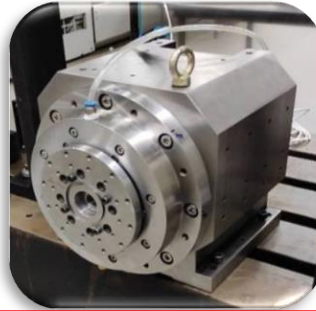
*Nanoslideway is designed & built specifically for exceptionally high stiffness and Nano-metric geometric characteristics. It incorporates a box type Preloaded Hydrostatic bearing driven by Linear motor, with outstanding stiffness, ideal for heavy or offset loading.*

Features	specifications
MODEL & TYPE	HS 200; Fully constrained oil hydrostatic, box way slide
TRAVEL	200 mm (8 Inch)
LOAD CAPACITY & STIFFNESS	1000Kg (10,000 N) 1000N/ $\mu$ m
DRIVE SYSTEM	Brushless DC Linear Motor
FEEDBACK TYPE	Ultra precision Glass Scale
FEEDBACK RESOLUTION	32 picometer
STRAIGHTNESS	HORIZONTAL : 0.2 $\mu$ m over full travel VERTICAL : 0.4 $\mu$ m over full travel
FEED RATE (WORKING)	UPTO 1000 mm/min



## Nano Manufacturing Technology Centre

## CENTRAL MANUFACTURING TECHNOLOGY INSTITUTE



**NANOSPIN – AIM<sup>80</sup>**

Aerostatic bearing spindle acts as the heart of ultra precision machines and metrology equipments.

- *Single Point Diamond Turning (SPDT)*
- *Ultra Precision Turning*
- *Ultra Precision Milling & Micro Milling*
- *Ultra Precision Grinding*
- *Form Testers*

### Technical Specifications:

Bearing Type	• Aerostatic Bearing
Motion Error	• ≤ 100nm
Spindle Speed	• 3,500 RPM
Stiffness	• Radial – 80 N/μm • Axial – 200 N/μm
Max. Load Capacity	• Radial – 750 N • Axial – 1000 N
Motor Type	• Integrated DC Brushless motor
Torque	• 5 N-m
Cooling	• Water Cooling

**Indigenously Developed Aerostatic Bearing Spindle with Nanometric Accuracy for Ultra Precision Machining & Metrology**

### Main Features

- *Motion Error in Nanometres*
- *High Bearing Stiffness*
- *High damping*
- *High Dimensional stability*
- *Near Zero Static Friction*
- *Near Zero Thermal Distortion*
- *No Harmonics*
- *No Air Hammer Effect*
- *Laminar Flow*
- *Higher Working Speed Range*
- *Integrated Motor*
- *Hollow Spindle for Vacuum Chuck*
- *Water Cooled*

## Nano Manufacturing Technology Centre

# SPINDLE ERROR SCOPE

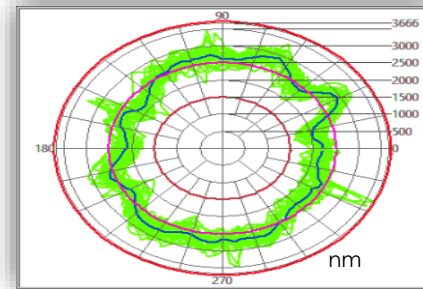
### TECHNICAL FEATURES:

The Spindle Error Scope is standalone module developed by CMTI for **measurement and analysis of spindle running accuracies**. The measurements of spindle error motions can be carried out **as per international standards (ASME B5.54, ISO 230-7) using this analyzer**. The system can measure geometrical errors (axial, radial & tilt) of spindles with both fixed and rotating sensitive directions. The analysis can separate the errors (synchronous and asynchronous). The frequency analysis can help in identification of the source of error. The analyzer can be also used to measure and analyze thermal drifts.

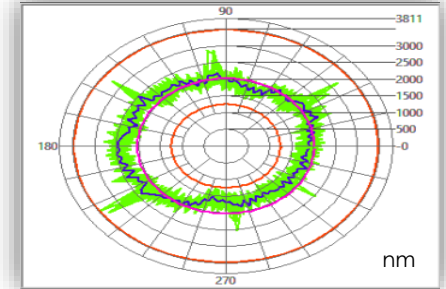
### Test Setup



### Portable Spindle Error Scope



Radial Error Polar Plot



Axial Error Polar Plot

### APPLICATIONS:

- ✓ All Machine Tool Spindle Manufacturers
- ✓ All spindle testing and repair organizations
- ✓ Machine tool testing and certification agencies

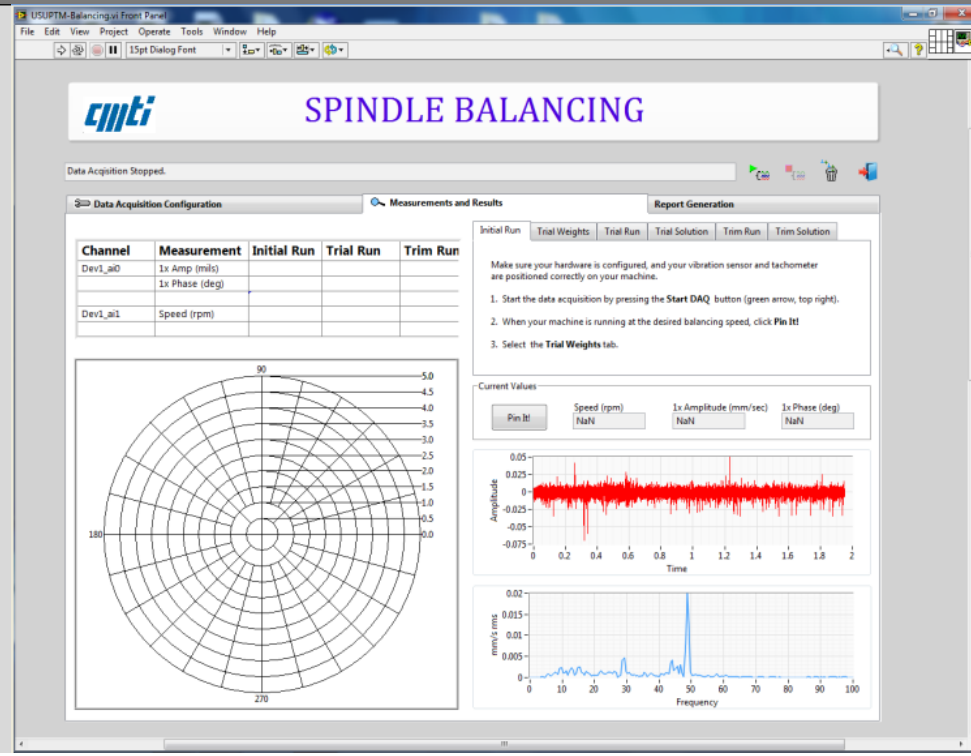
# Nano Manufacturing Technology Centre

## On Machine Spindle Balancing

The On Machine Spindle Balancing is a software solution used for balancing the precision spindles and fixtures used in precision machines by using sensors and data acquisition system. The software assists the user to correct the unbalance by measuring the vibrations and phase information. The software module calculates how much and where to add or remove the weights to balance the rotor element/spindle/fixture along with phase information for the precision machines.

### Salient Features:

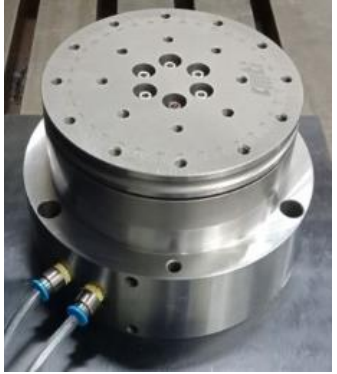
- Single / Double Plane Balancing
- User Friendly Software
- Cost effective solution



# Nano Manufacturing Technology Centre

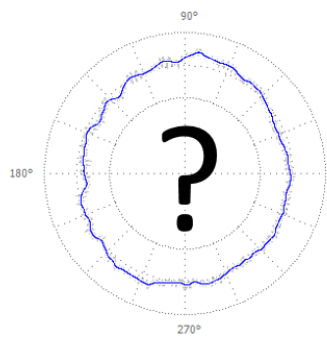
## Air Bearing Rotary stage

- Air Bearing Rotary Stage can be used as rotary-axis on low cost table top roundness/ form tester Machines.
- Air Bearing Rotary Stage has been developed at CMTI to aid as an aggregate for Metrology Equipments like Form testers.



### TARGETED SPECIFICATIONS

Major Specification	Values
Bearing type	Aerostatic bearing
Overall Bearing Running Accuracy	< 50nm
Table Size (Dia)	120 mm
Air bearing stage height	120-130mm
Load Capacity	< 20 Kg
Max. Speed	100 RPM
Drive	Belt drive motor
Working pressure	7 bar



Air Bearing Rotary stage

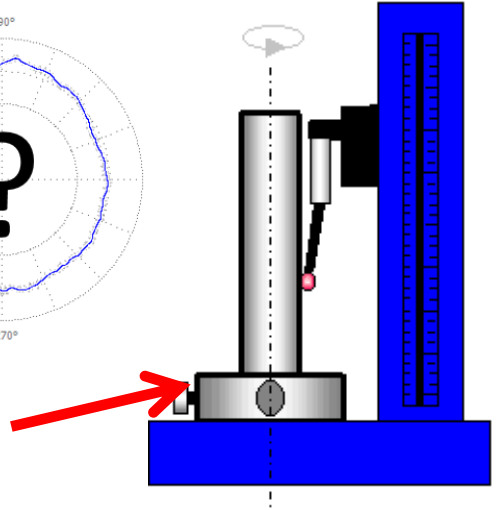
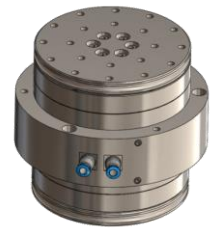
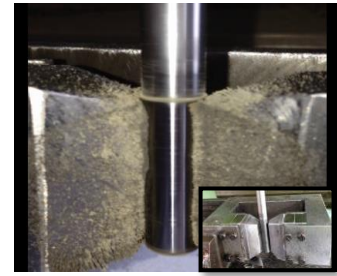
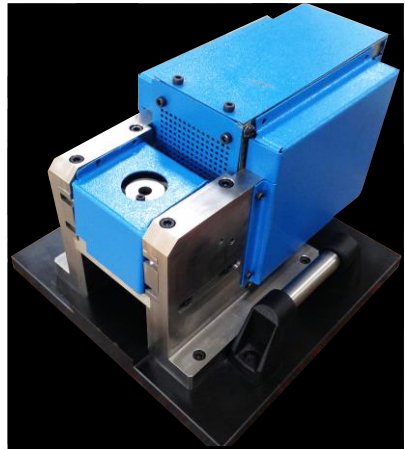


Fig: Schematic of Roundness tester

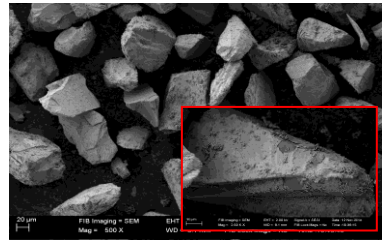
# Nano Manufacturing Technology Centre

## MAGNETIC ABRASIVE FINISHING TECHNOLOGY

The Magnetic Abrasive Finishing Technology: **A Superfinishing Technology** developed particularly to suit Cylindrical Components.



**Cylindrical Rod Finishing**  
Upto 20nm (Ra)



**Magnetic Abrasive Media**  
[Diamond, Silicon Carbide, Quartz]  
*(In-house Development)*

### MAF Advantage

- ❖ Process is comparatively very economical
- ❖ Can Achieve surface finish up to 20nm or better
- ❖ MRR can be controlled by varying brush stiffness
- ❖ No dressing required as abrasives self align and sharpen
- ❖ Can finish both external and internal surface of tubular components

**Applications:** IC Engine Valves, Bearings, ID and OD of Precision Cylindrical Components, Moulds etc.



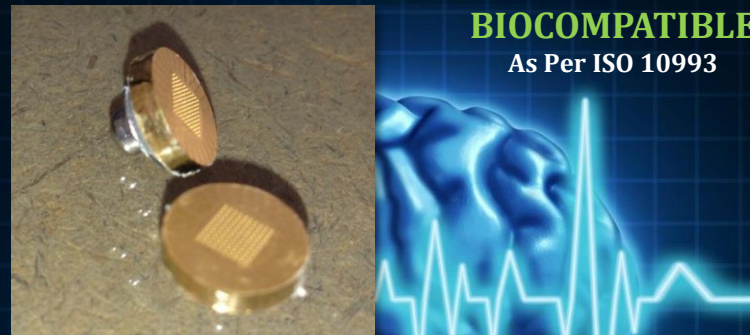
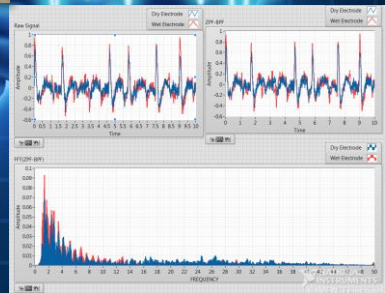
CMTI in collaboration with IIT Kanpur has developed MAF Technology for Nanofinishing of components used in industrial application. Under the effect of magnetic field, magnetic abrasives are arranged orderly along the magnetic line to form a flexible abrasive brush. Finishing happens when there is relative motion between the magnetic abrasive brush and the work piece. **CMTI can develop Tools and Equipment to meet industrial requirements in nanofinishing of precision components using MAF Technology**

Nano Manufacturing Technology Centre


**MICRONEEDLE ELECTRODE TECHNOLOGY**

**MICRONEEDLE PATCH..... Future Ready!! For Painless, Accurate and Long-**

**BIOCOMPATIBLE**  
As Per ISO 10993

**CORRELATION RESULTS WITH WET ELECTRODE**



Microneedle Patch can be used for **EEG Measurement**, Sleep and Alertness monitoring, Anaesthesia monitoring, Diabetes treatment, Electrophoresis treatment, Drug Delivery (with drug coating) and many more life saving applications.

100 μm FIB Imaging = SEM EHT = 2.00 kV Signal A = SESI Date :9 Mar 2016  
Mag = 250 X WD = 7.2 mm FIB Lock Mags = No Time :17:35:54