MaSE
(Material Manufacturing and Surface Engineering Research Center)

King Mongkut's University of Technology North Bangkok

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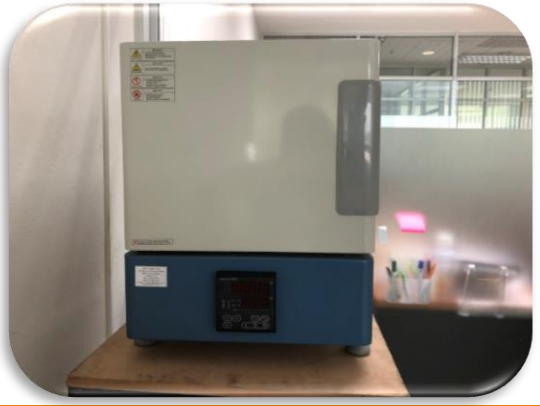
Industrial Oriented Research at Material Manufacturing and Surface Engineering Research Center, MaSE



OUTLINE

- About Material Manufacturing and Surface Engineering Research Center (MaSE)
- Research
- Facilities

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About MaSE

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Mission : Provide Innovative Eco System to Support Industry Demand

Structure : Multi-displinary and Multi-Education Levels and Skills Collaboration.

Network and Collaboration Examples:

Researcher

Dr. Karuna Tuchinda

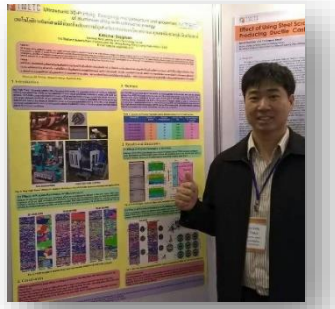
- Director of CRDC-FC
- Lecturer and Researcher

Mechanical Engineering Simulation and Design (MESD)
Department of Mechanical and Process Engineering (MEPE)
The Sirindhorn International Thai-German Graduate School of Engineering (TGGS)
King Mongkut's University of Technology North Bangkok

Asst. Prof. Dr. Yingyot Aueulan

- Lecturer and Researcher

Materials and Production Engineering (MPE)
Department of Mechanical and Process Engineering (MEPE)
The Sirindhorn International Thai-German Graduate School of Engineering (TGGS)
King Mongkut's University of Technology North Bangkok



Dr. Kittichai Sojiphan

- Committee of Materials Research Society of Thailand (MRS-Thailand)
- Head of Center for Welding and Materials Joining Research Network (CWMJ) of the Welding Institute of Thailand
- Lecturer and Researcher

Department of Welding Engineering Technology
College of Industrial Technology
King Mongkut's University of Technology North Bangkok

Dr. Sithipong Mahathanabodee

- Head of Graduate school
- Lecturer and Researcher

Production Engineering Department
Engineering Faculty
King Mongkut's University of Technology North Bangkok

Network Consultant

Dr. Siriporn Larpkiattaworn

Director of Expert Centre of Innovative Materials (InnoMat)

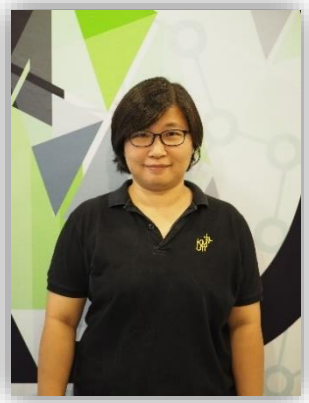
Thailand Institute of Scientific and Technological Research (TISTR)

People and MaSE

PhD. Candidates

Pudsadee Chupong

Maitri Kamonrattanapisud



Kessaraporn Wathanyu

Kaweewat Worasaen

Mahathep Sukpat

Nuwan Wannaprawat

Network Researchers

Nattarat Kengkla
Researcher
Department of Tool and Materials Engineering
Faculty of Engineering
King Mongkut's University of Technology Thonburi

Tharanon Usana-ampaipong
Technical support
Acme International (Thailand) Ltd.

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Research

Materials Technology Research

by Dr. Sithipong Mahathanabodee
- Head of Graduate school
- Lecturer and Researcher
Production Engineering Department
Engineering Faculty
King Mongkut's University of Technology North Bangkok

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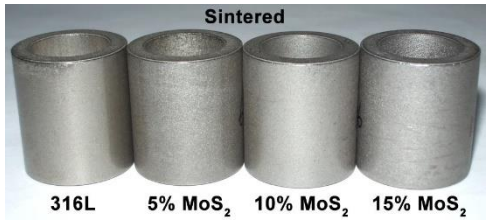
Materials Technology Research

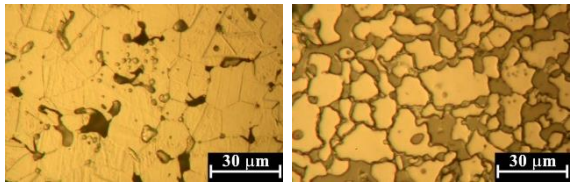
KMUTNB

by

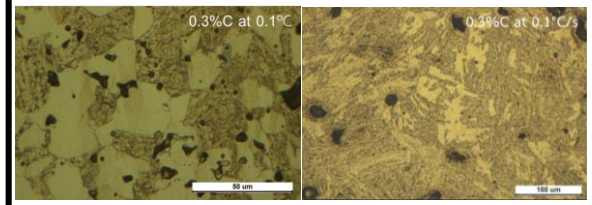
Dr. Sithipong Mahathanabodee

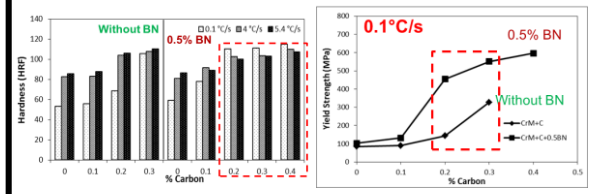
Production Engineering Department
Engineering Faculty
KMUTNB



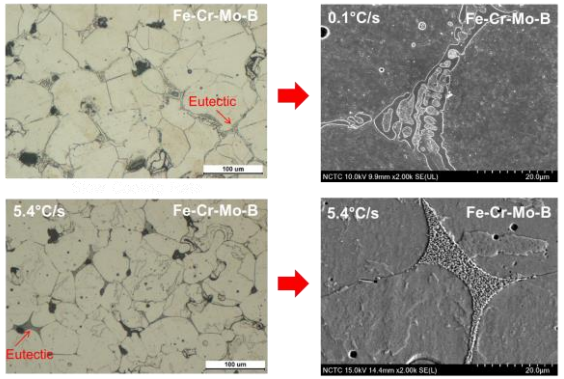


Stainless Steel/MoS_2 Composites

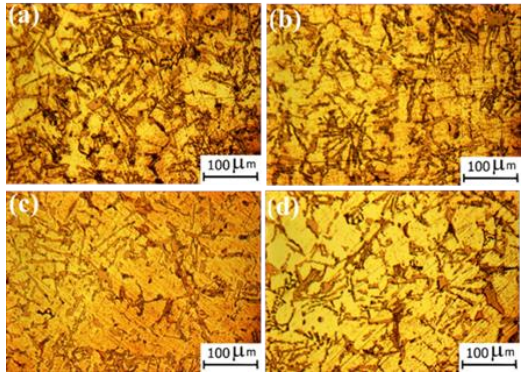


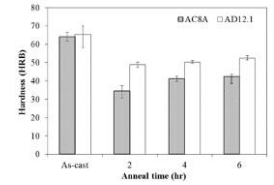


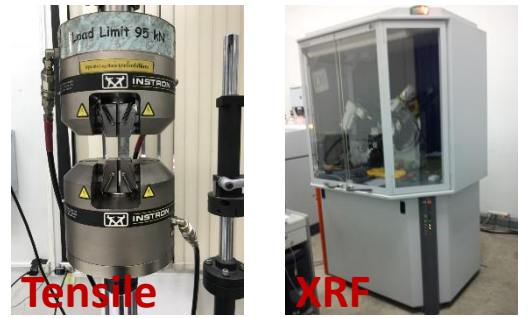
Sintered Fe-Cr-Mo Steel
with h-BN additions

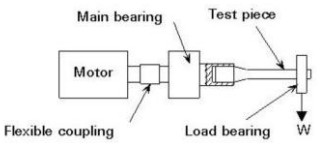


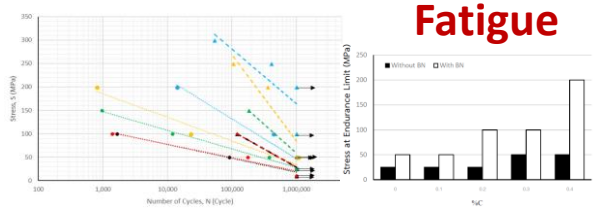
Effect of Cooling Rate on Sintered
Fe-Cr-Mo Steel with h-BN additions





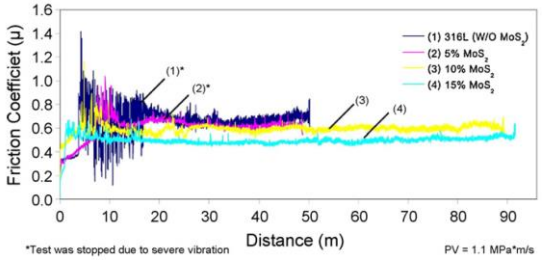


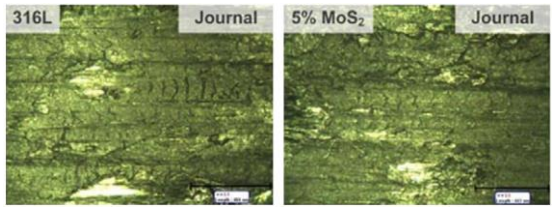


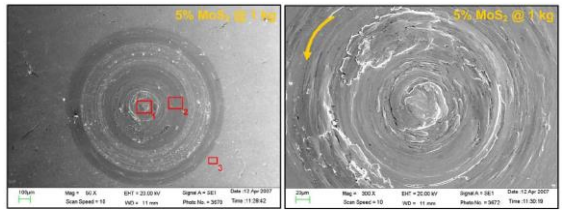


Powder Metallurgy **Heat Treatment** **Materials Testing & Characterization**

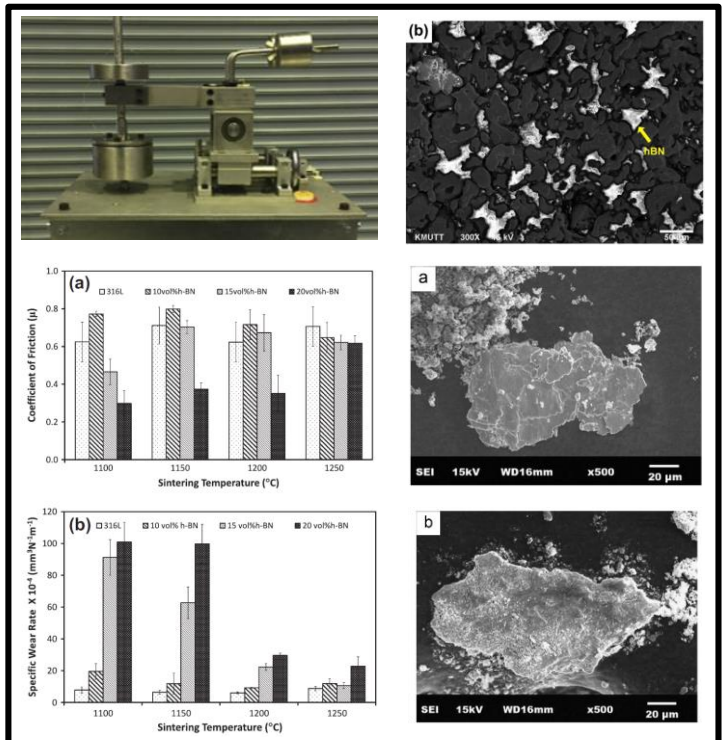
Tribology (Friction, Wear and Lubrication)



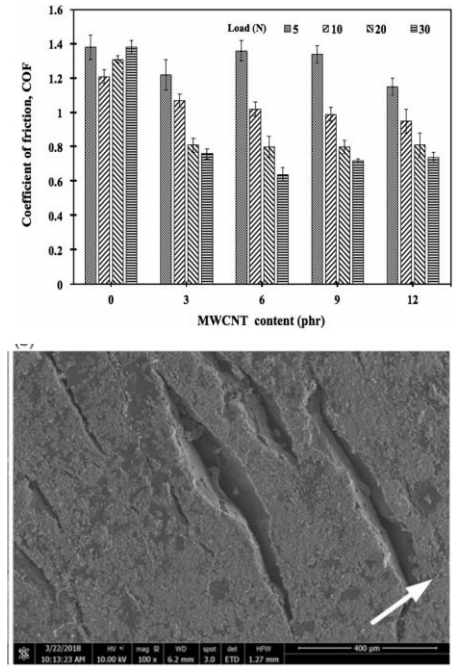




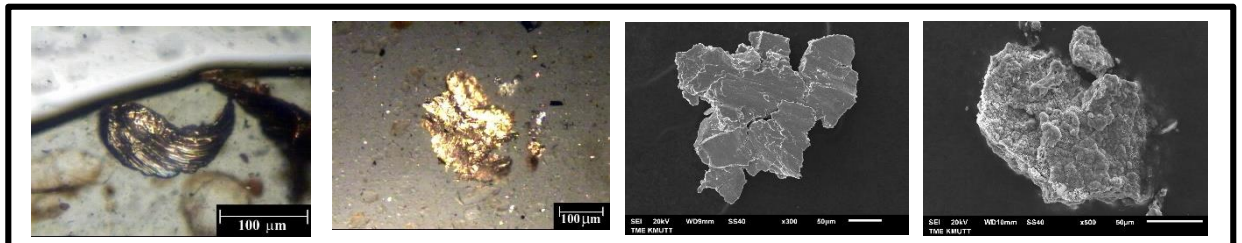
Friction and Wear of Stainless Steel Composites



Tribological Properties of Sintered 316L/h-BN



Tribological Properties of Carbon Nanotube/NBR Composites



Used lubricants analysis and wear debris analysis

Medical Application

Gradient porous coating of Ti on Stainless Steel Biomaterial

By Kessaraporn Wathanyu
PhD student in Mechanical Engineering Program
Minor Mechanical Engineering Simulation and Design
The Siridhorn International Thai-German Graduate School of Engineering
King Mongkut's University of Technology North Bangkok

Stainless steel 316L

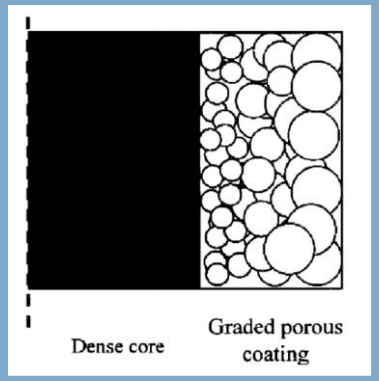
- More use in Asia
- Fixation Problem
  : loosening implant

Decrease fixation problem with Porous surface

Problem of porous surface (interface)

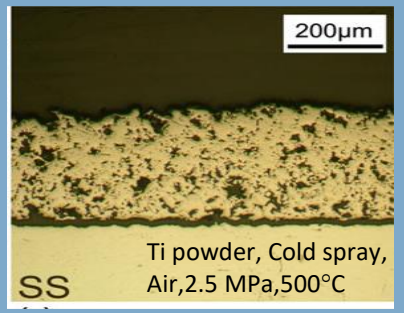
- Sensitive to pitting & crevice corrosion [P.A. Revell,2014]
- Release of debris into the human body [Silva-Bermudez and Rodil, 2013]

Ti Gradient porous coated on 316L



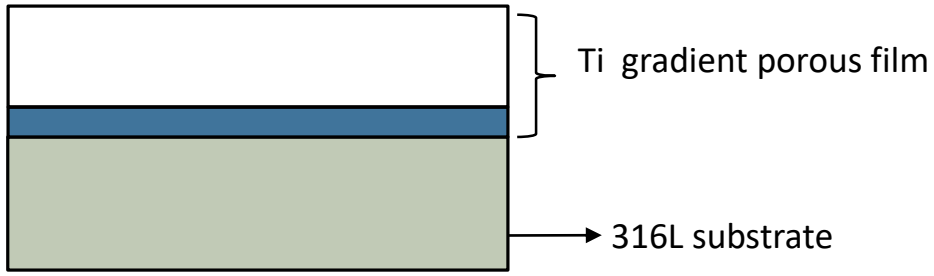
Cold spray coating
Difficult deposited Ti on 316L

- 316L and Ti are hard metal.
- Different crystal structure



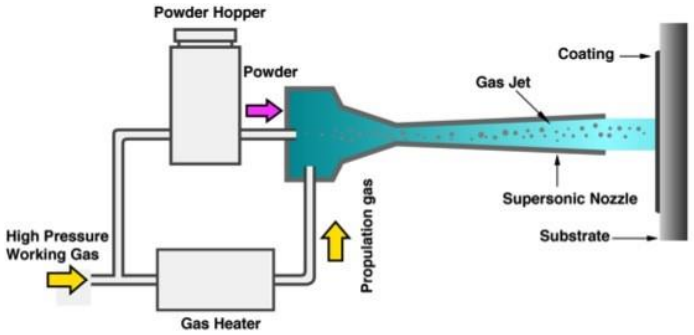
Shuo Yin, et al,(2014)

In this research :
Creating Ti gradient porous film by cold spray

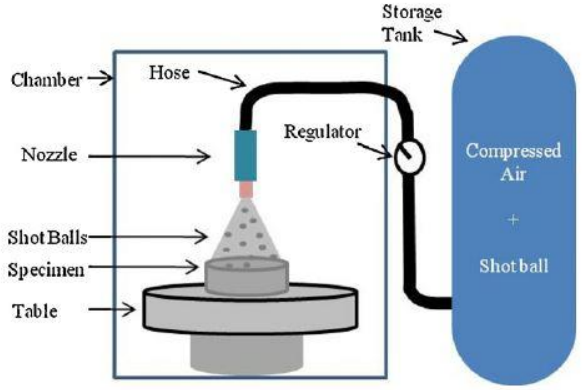


Manufacturing Application

Improvement of Tool Steel Surface Property by Mechanical Based Process



http://www.mecpl.com/cold-spray.php



[Kyun Taek Cho et al, 2012]

By Pudsadee Chupong
PhD student in Mechanical Engineering Program
Minor Mechanical Engineering Simulation and Design
The SiridhornInternational Thai-German Graduate School of Engineering
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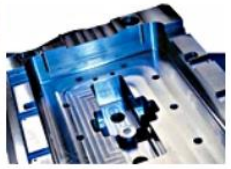
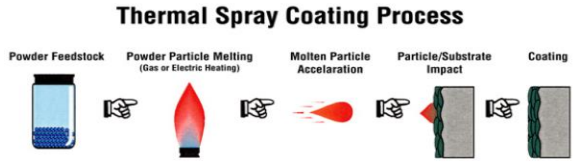
Background

Manufacturing is a major industry in Thailand. Thai industries have attempted to improve and develop their technology, production, machine, mold and die for forming part such as automotive parts and electronic parts, which is one of the most important industry.



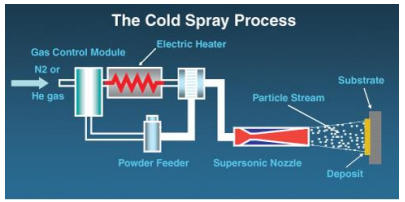


http://www.maxsteelthai.com/index.php?option=com_content&view=article&id=122:-tool-steels&catid=42



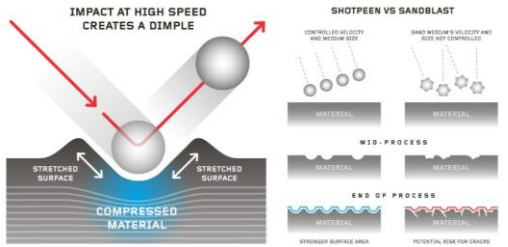
http://www.tungsten-powder.com/What-is-Thermal-Spray.html

- Available in Thailand
- Use high temperature
- More oxidation
- More porous



https://vrcmetalsystems.com/technology-cold-spray/

- Not available in Thailand
- Use low temperature
- Low oxidation
- Coating were dense



http://spank-ind.com/shotpeen-upgrade.php

- Available in Thailand
- No coating layer
- Create residual stress
- Improve fatigue life

We had shot peening machine and want to study the possibility of modification of shot peening based process using cold spray process technology.

process from local SMEs company

Improvement of Copper Alloy Performance by Cryogenic Treatment

By Nuwan Wannaprawat
PhD student in Mechanical Engineering Program
Minor Mechanical Engineering Simulation and Design
The SiridhornInternational Thai-German Graduate School of Engineering
King Mongkut's University of Technology North Bangkok

Motivation

Improve Materials properties of Copper Beryllium Alloy

Objective of research

Improve the service life of Copper Beryllium Alloy by using Cryogenic Treatment Process

To study relationship of Cryogenic Treatment Process. It has effect to transformation of Microstructure and Materials properties.

Assumption

Cryogenic treatment Process lead to produce fine precipitates and modify microstructure to improve materials properties

Expectation

Cryogenic treatment process can improve Copper Beryllium Alloy performance

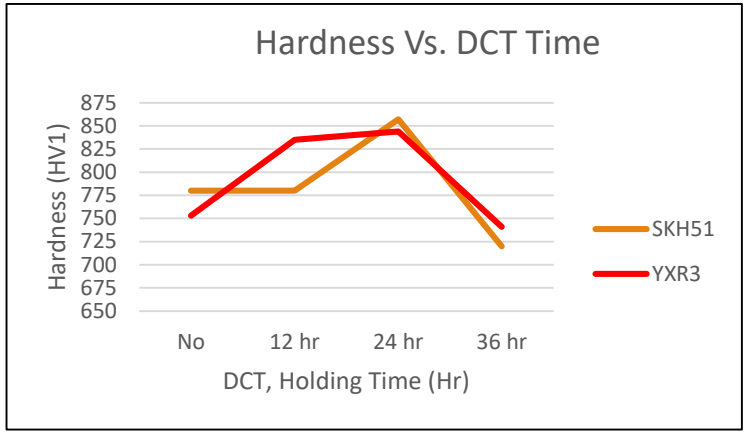
The knowledge of research can apply to other Materials and Processes

Influence of Cryogenic Treatment on Life of Tool Materials

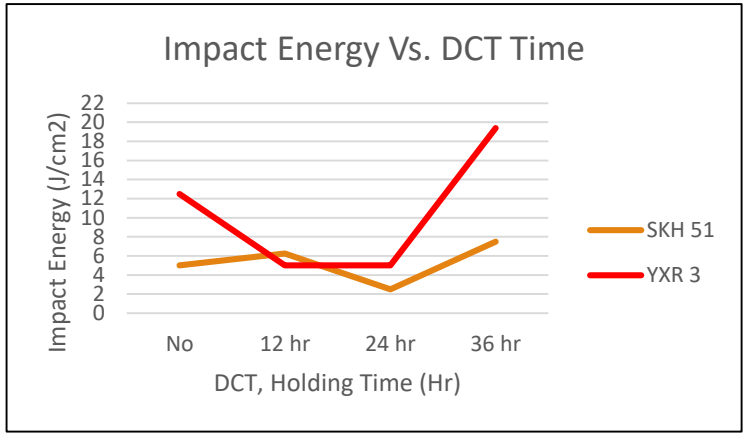
By Kaweewat Worasaen
PhD student in Mechanical Engineering Program
Minor Mechanical Engineering Simulation and Design
The SiridhornInternational Thai-German Graduate School of Engineering
King Mongkut's University of Technology North Bangkok

Objectives

- To develop the fracture toughness predicted modelling based on microstructural parameters by controlling thermal treatment process.
- To investigate the optimum deep-cryogenic treatment parameters.
- To improve the mechanical properties of Tool steels.



Hardness Results Vs. Deep cryogenic soaking time (DCT)



Impact energy Vs. Deep cryogenic soaking time (DCT)

Current Findings

- Retained austenite transformed to martensite. → Hardness increase, Toughness decrease
- Carbon atom in martensite are forced to diffuse by shrinkage in the structure and make a new carbide nucleus (secondary carbide). → Hardness decrease, Toughness increase (36 hr soaking time).

Power Generation Application

Fatigue Property Evaluation for Power Generation Application Material

By Mahathep Sukpat
PhD student in Mechanical Engineering Program
Minor Mechanical Engineering Simulation and Design
The SiridhornInternational Thai-German Graduate School of Engineering
King Mongkut's University of Technology North Bangkok

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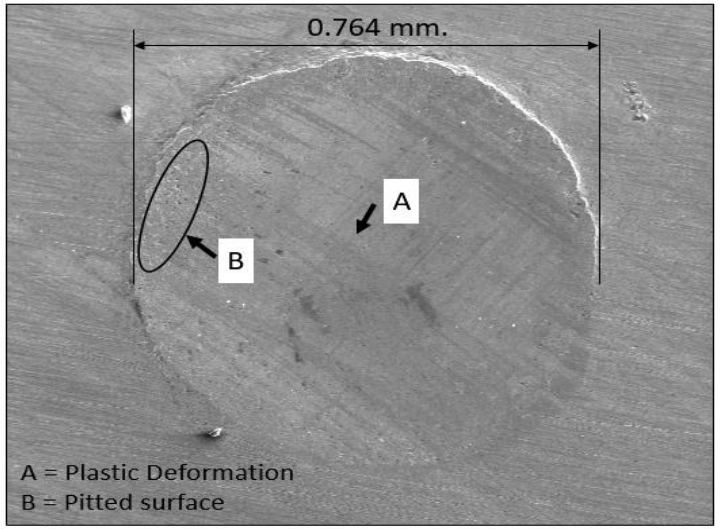
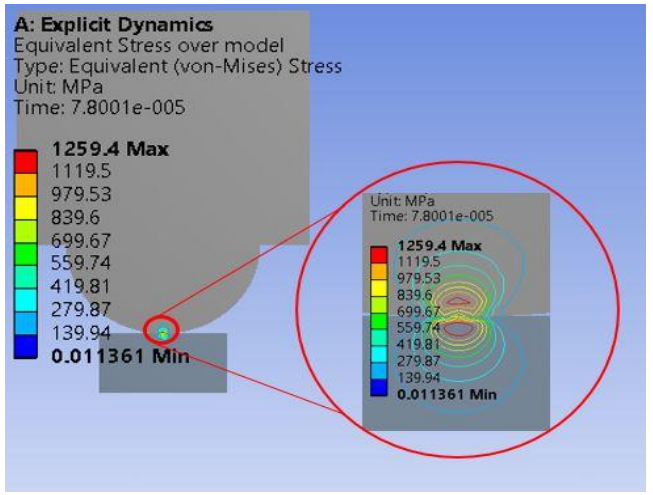
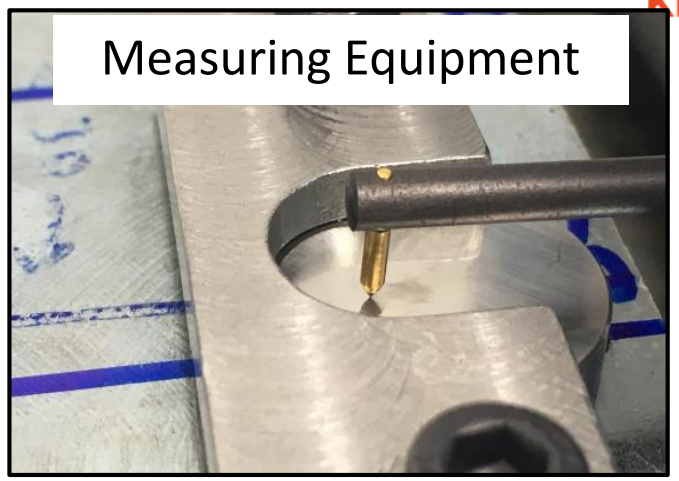
Objective:

- To investigate the local fatigue properties at the surface of the specimen

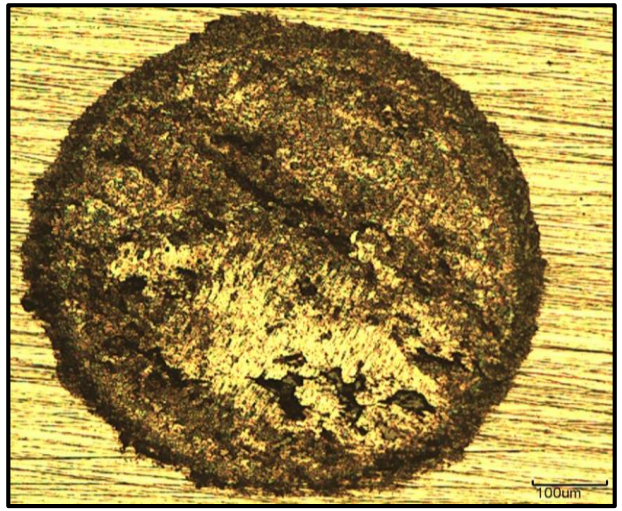




Wear profile



Wear surface



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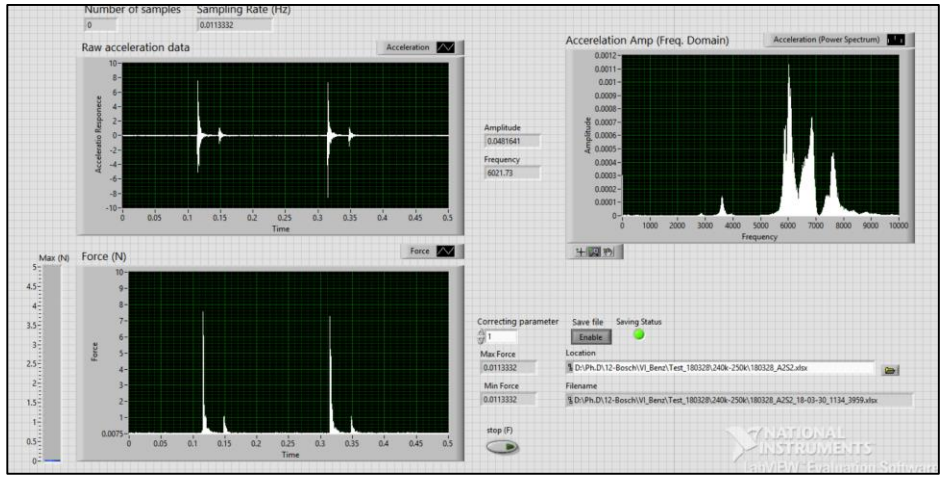
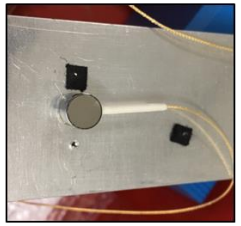
Develop Real-time force and response measurement procedure



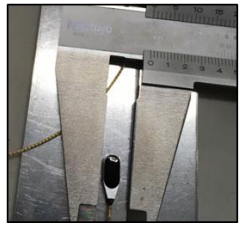
Develop Local Failure Detection Methodology by AE Sensor

a)

b)

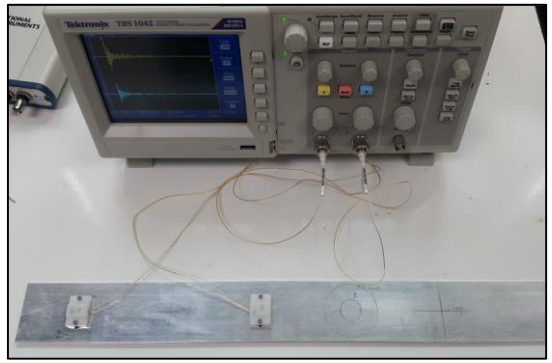


c)



Amplifier

Filter



Automotive Application

Computational study of friction materials: Application to clutch

By Maitri Kamonrattanapisud
PhD student in Mechanical Engineering Program
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The SiridhornInternational Thai-German Graduate School of Engineering
King Mongkut's University of Technology North Bangkok

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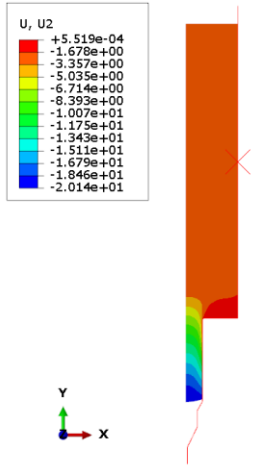
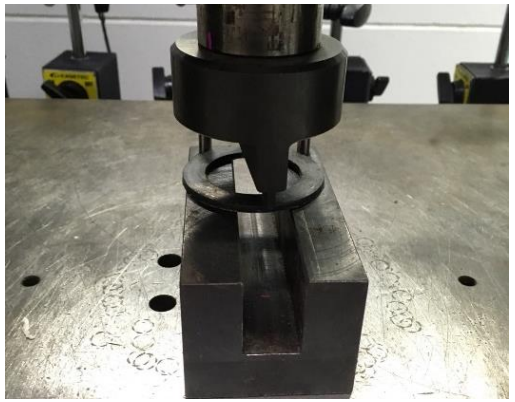
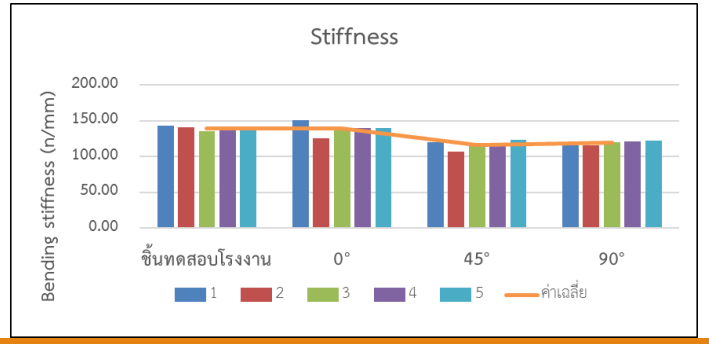
Objective : Develop computational based methodology to predict mechanical and tribological performance of materials

Modelling of manufacturing process

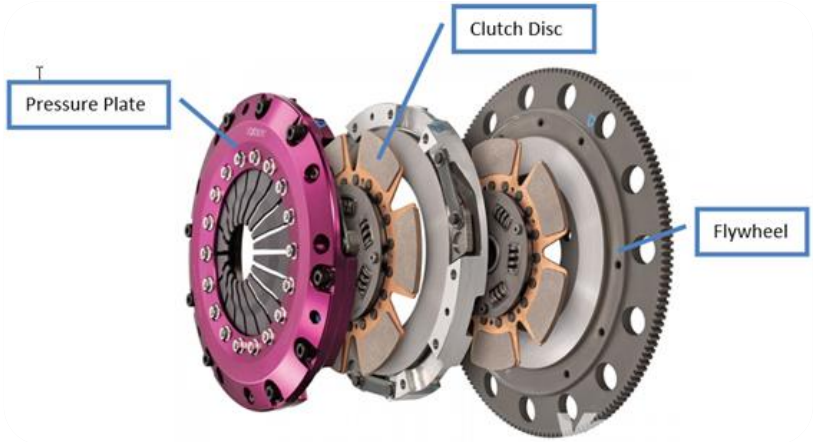


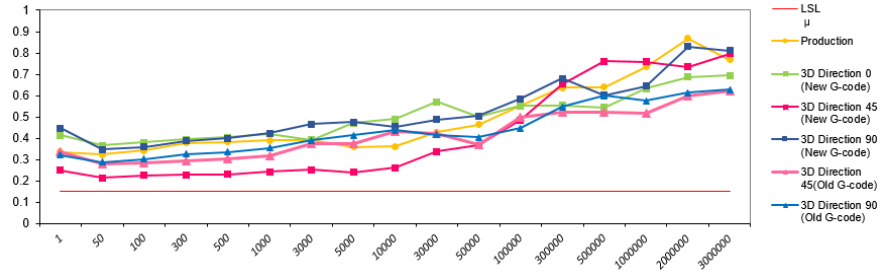
Modelling of testing process





Design and Predict Performance under tribology test





Agricultural part application

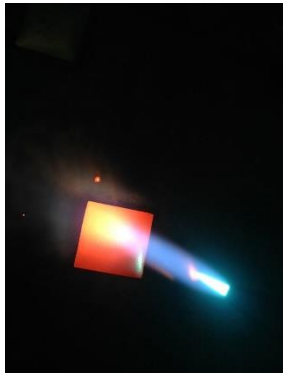


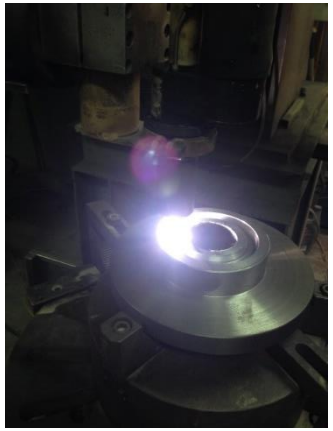
Abrasive wear !!

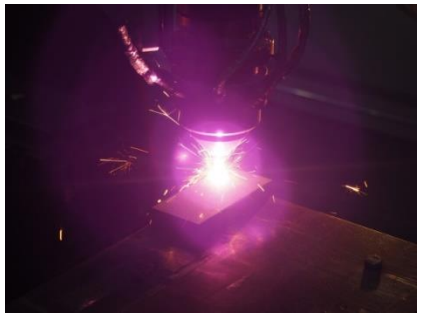
Need high hardness surface

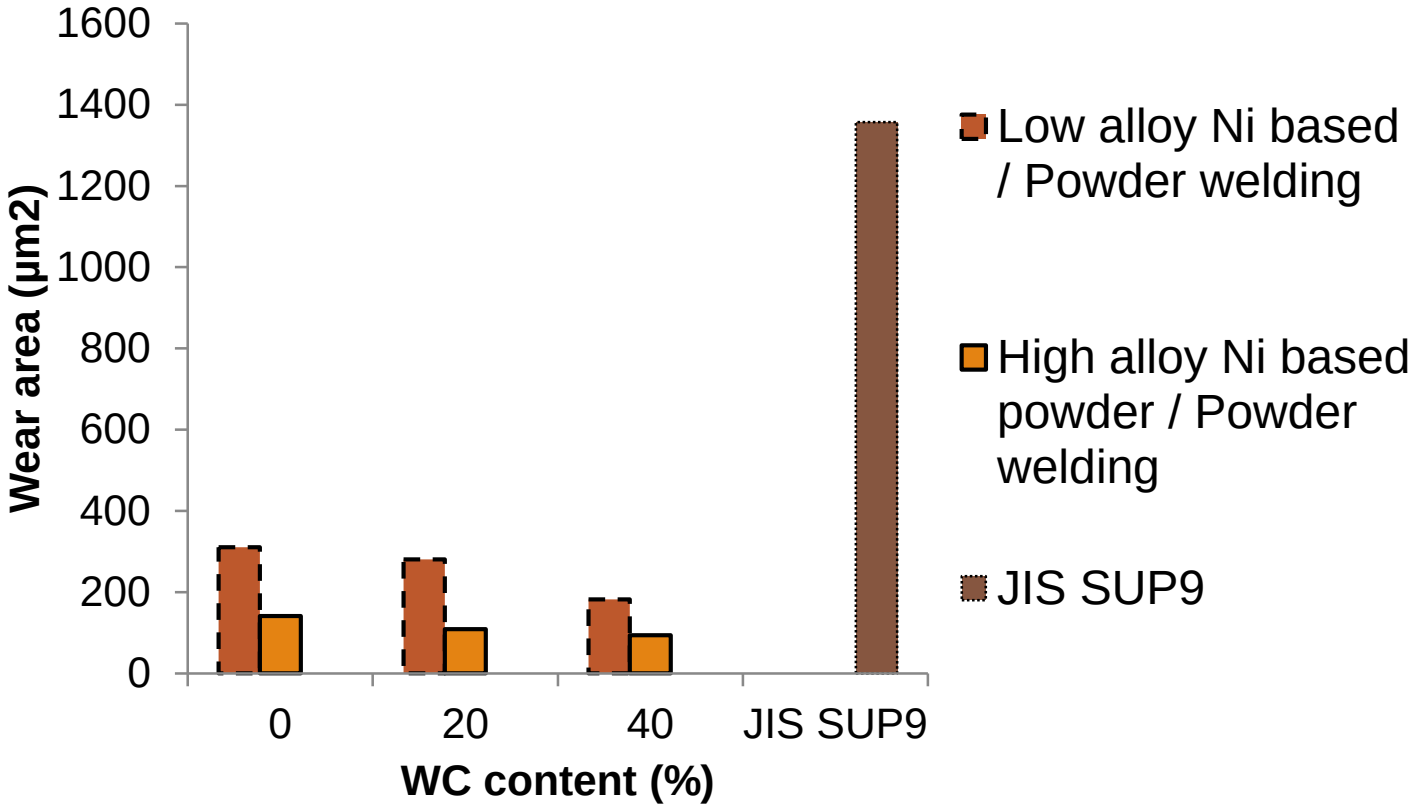
High replacement cost

Solution: Apply hard wear resistance coating with spray based process



Flame spray & fuse


Plasma transferred arc


Laser cladding



Wear rate (Lab scale)

- **At least 3.5 x lifetime increase** after coating.
- Higher WC, lower wear rate.
- Higher alloy, lower wear rate.
- **14.6 x lifetime increase** - high alloy Ni based + 40% WC

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(Material Manufacturing and Surface Engineering Research Center)

KMUTNB

Facilities

X-ray residual stress analyzer “μ-X360”

1. X-ray tube Cr and V (for non ferrous)
2. Measurement residual stress, FWHM, retain austenite

Polishing machine

Diamond cutting machine

Fiber injection molding machine

Heat treatment furnace

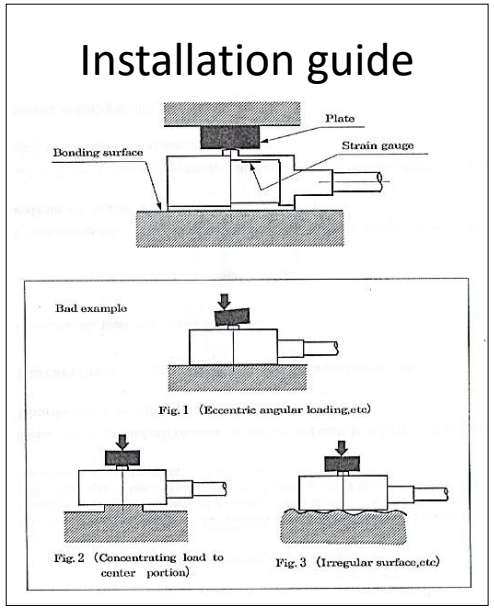
Cryogenic treatment , Chovachot,
Min. Temperature -140 °C
Max. during time 4 hours

Force Sensor (Strain gauge base)

Small loading range: 0-20 N

Real Part

Installation guide

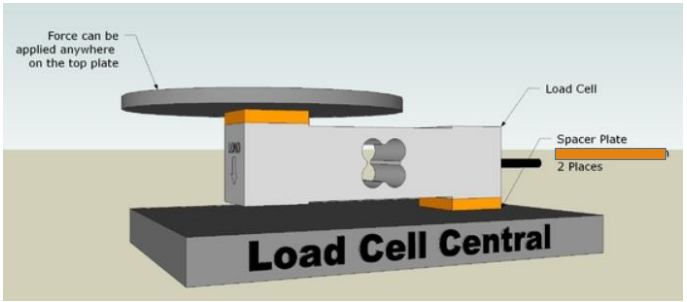


Force Sensor (Strain gauge base)

Medium load range : 0-100 N

Real Part

Installation guide



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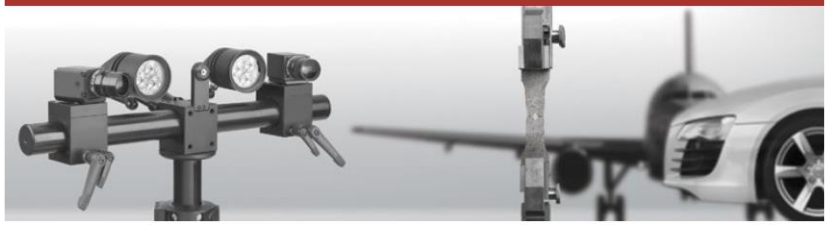
ARAMIS



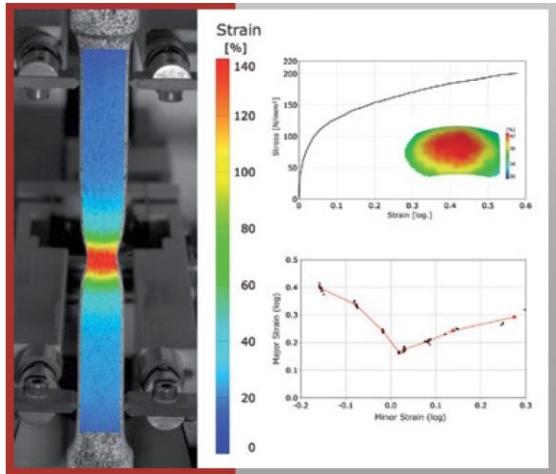
ARAMIS Features

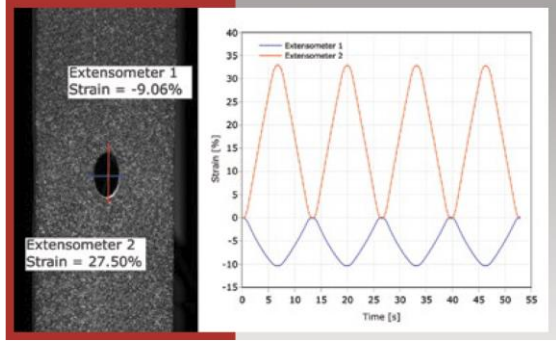
- Non-contact
- Material independent
- Geometry independent
- 2D and 3D measurement
- Mobile and flexible
- Full-field
- High accuracy
- High temperature
- High speed
- Easy specimen preparation
- Integration in testing environments
- Smallest to largest object sizes
- Smallest to largest deformations

Optical 3D Deformation Analysis

3D Surface - Displacements - Strains
in Material and Component Testing

gom





- High temperature tests
- High speed tests
- Very small specimen sizes

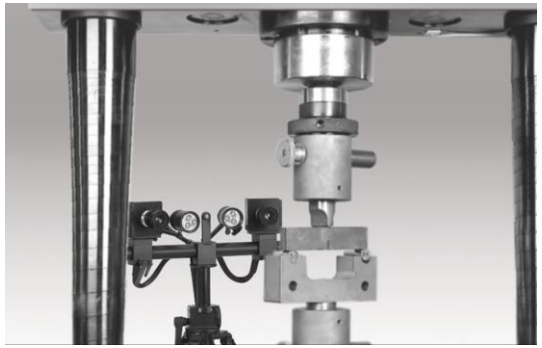
Today, ARAMIS is an established and proven measuring solution in hundreds of material research facilities around the world for:

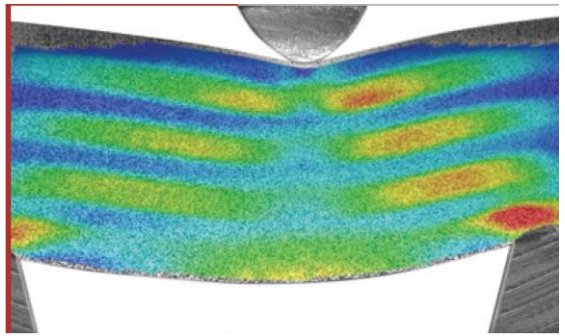
- Strain-Stress evaluation
- R-Values
- Poisson ratio
- Young's modulus
- Forming limit curves
- Residual stress
- Shear modulus

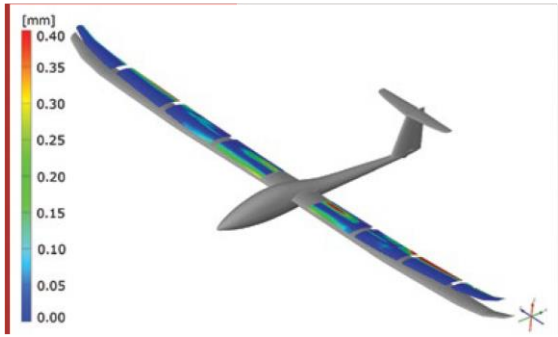
Real-Time 3D measuring

ARAMIS provides real-time results for multiple measurement positions on a specimen's surface. These are directly transferred to testing devices, data acquisition units or processing softwares (e.g. LabView, DIAdem, MSExcel, etc.) and are used for

- Controlling of testing devices
- Long-term tests with smallest storage requirements
- Vibration analysis
- 3D Video Extensometer







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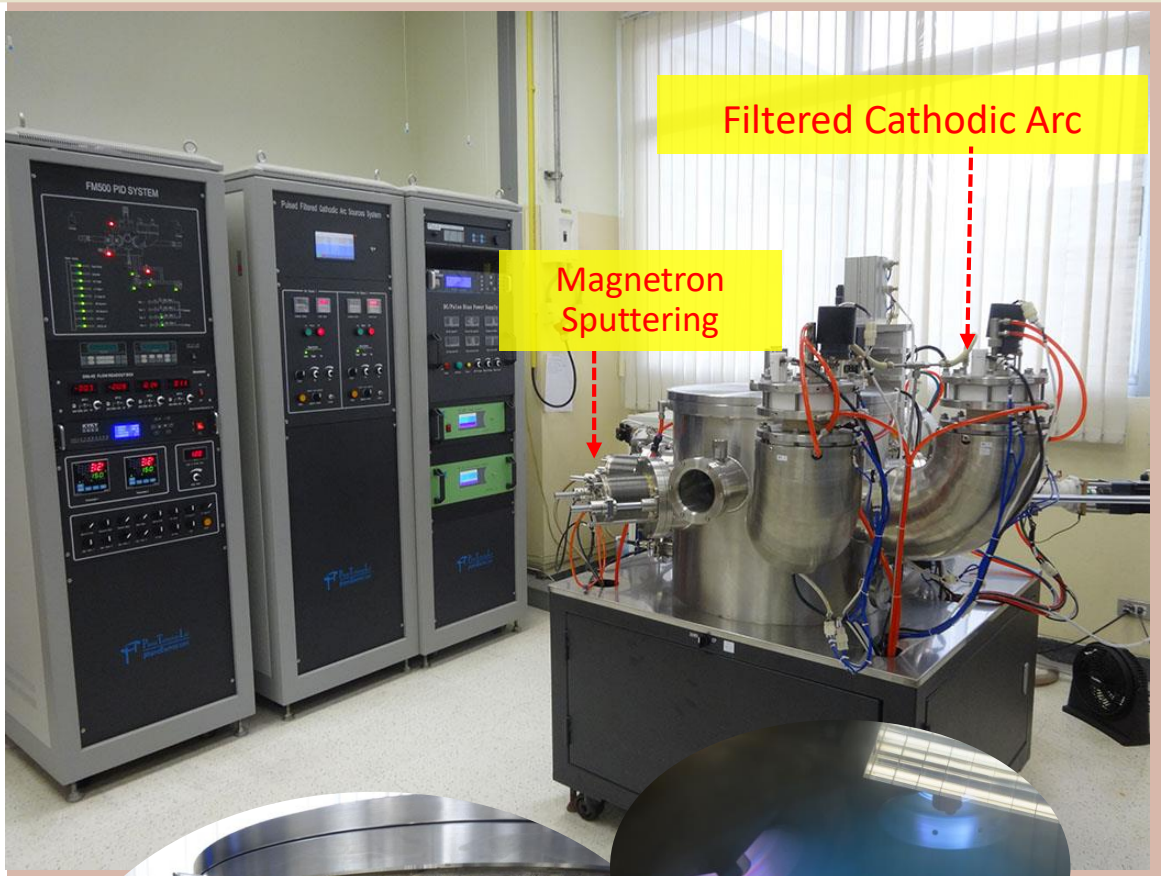
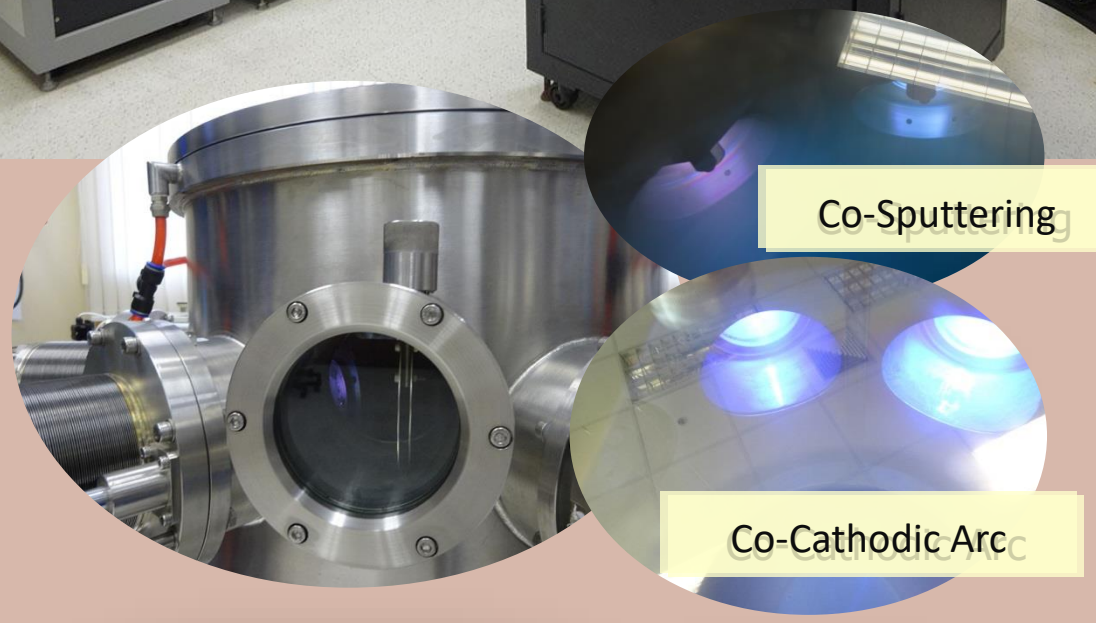
Network Facilities

Thin Film System and Characterization

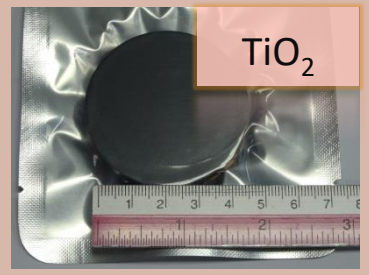
Dr. Siriporn Larpkiattaworn
Director
Expert Centre of Innovative Materials (InnoMat)
Thailand Institute of Scientific and Technological Research (TISTR)

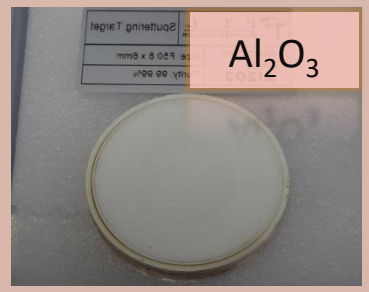
Plasma Implantation and Deposition System

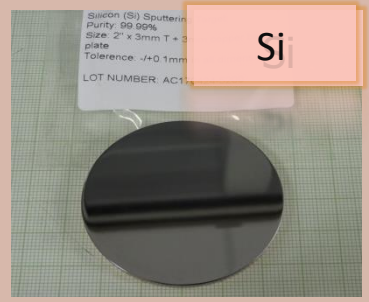




Sputter target
- Metal
- Non-metal





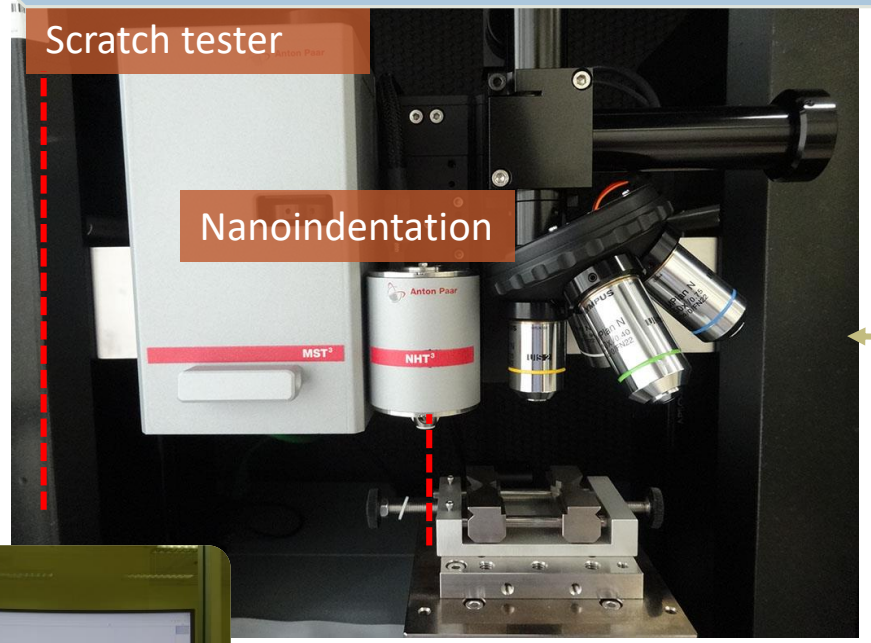


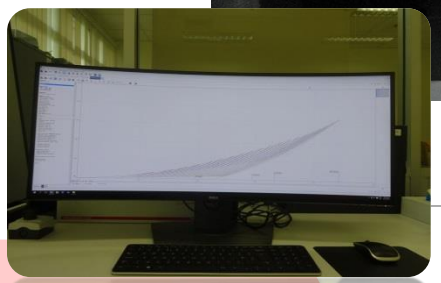
Cathodic arc target
- Metal

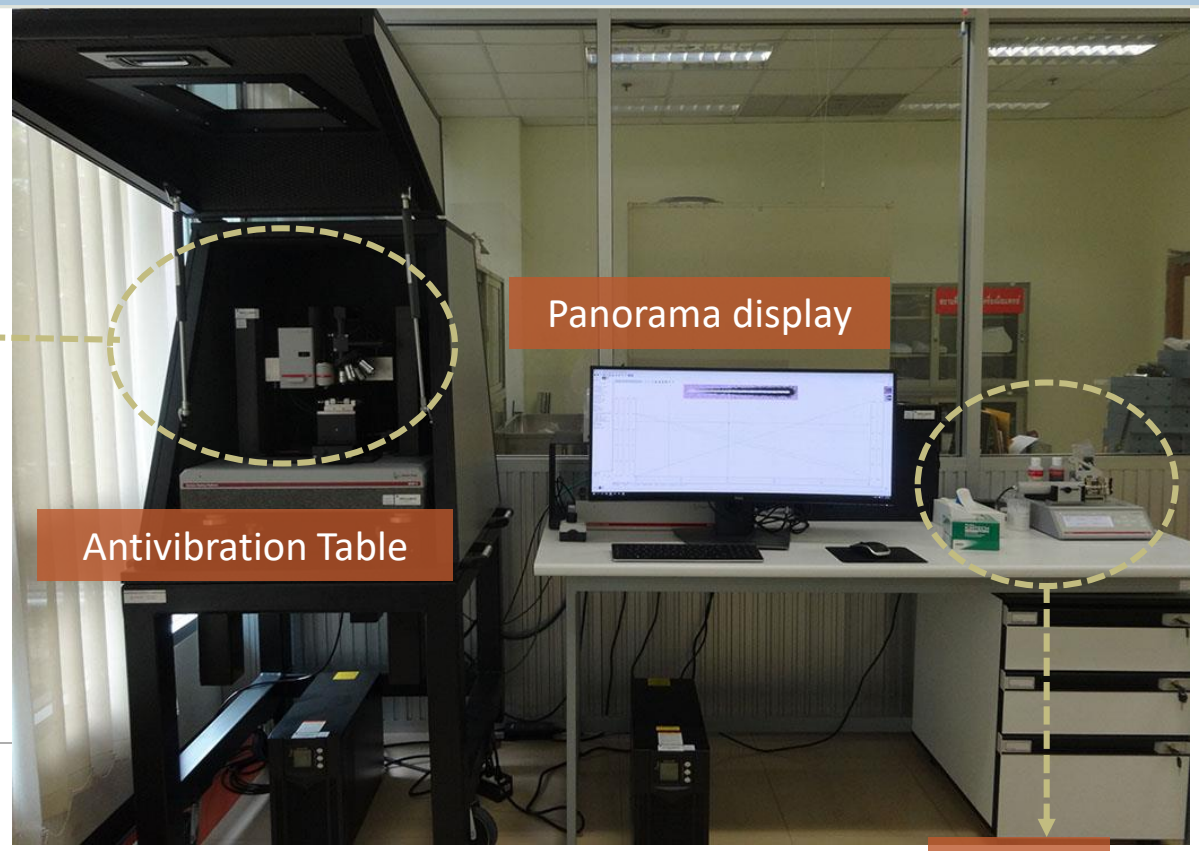
- 2 Pulse filtered cathodic vacuum arc sources
- 2 Magnetron sputtering
  - DC sputtering
  - RF sputtering
- 1 RF CCP plasma source for surface cleaning and assisting ion implantation/deposition
- 1 High voltage pulse modulator HVPM for Plasma Immersion Ion Implantation
- 1 DC/Pulse bias power supply for thin film deposition
- 1 High voltage substrate holder
- 2 Low voltage substrate stage

Mechanical Test

Equipments







Micro scratch tester (MST3)

- Scratch testing

Load range : 0.01 to 30 N
Depth range 0- 1000 µm
Spherical indenter with calibration certificate
Rockwell C diamond

Nanoindentation (NHT3)

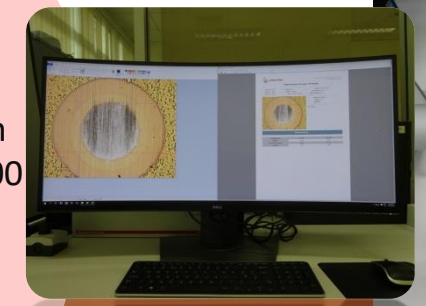
- Hardness
- Elastic modulus

Load range : 0-500 mN
Depth range : 0-200 µm
Berkovich diamond indenter

Compact Calotest

- Thickness of films

sample diameter : up to 32 mm
Bi-directional motor : 300 - 3000 rpm range
Stainless Steel balls ø : 10, 15, 20, 25.4, 30 mm



Chemical and Microstructure

Equipments

X-ray diffractometer (XRD)

XRD : Rigaku SmartLab

- Bragg Bentano (BB) : powder sample
- Parallel Beam (PB) Method : Grazing incident, residual stress
- High Resolution X-Ray Diffraction (HRXRD) of Epitaxial Thin Films : can measure Structural Information and defect
- X-ray reflectivity (XRR) : can measure thickness, Surface and Interface Roughness, density or composition of the topmost layer

XRF : Bruker S8 TIGER

- Solid and liquid samples can be analyzed
- Little or no sample preparation required
- Analysis is non-destructive (for the sample)
- Quantitative and qualitative analyses are possible
- Accuracy and long term stability
- Linearity from ppm to 100%

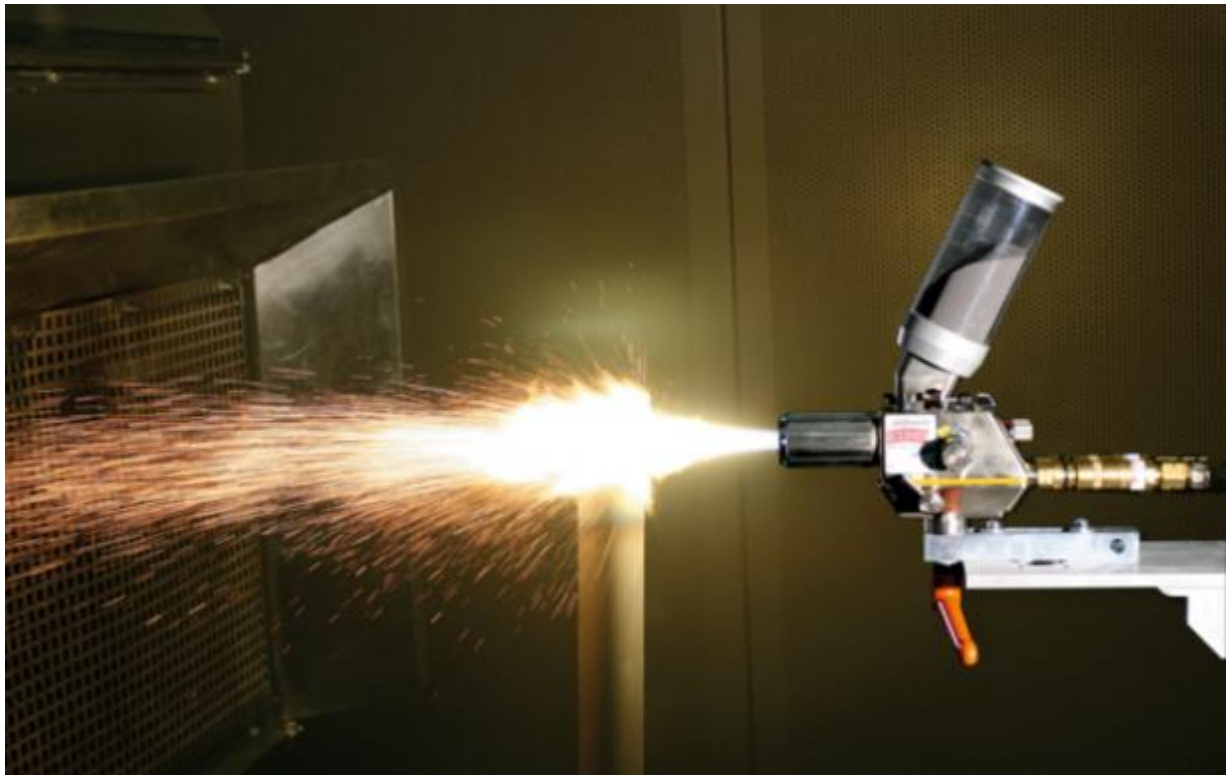
X-ray fluorescence (XRF)

Field emission scanning electron microscope (FE-SEM)

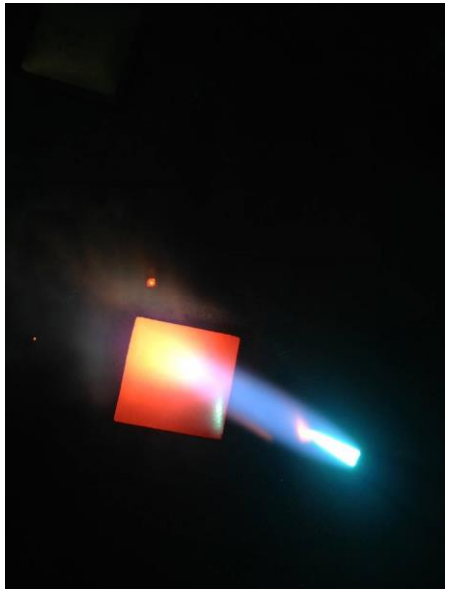
FE-SEM : JEOL-JEM 6340J

- Surface morphology and cross-section of thin films can be analyzed
- Thin layer of films can be measured
- The finest Structural morphology can be observed up to 100,000x

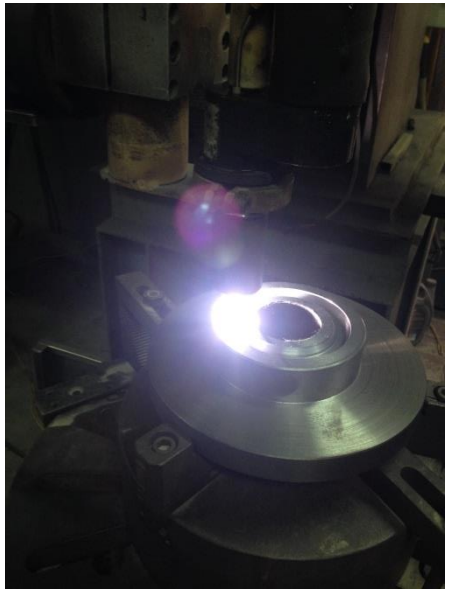
Spray System at Industrial Partner Site



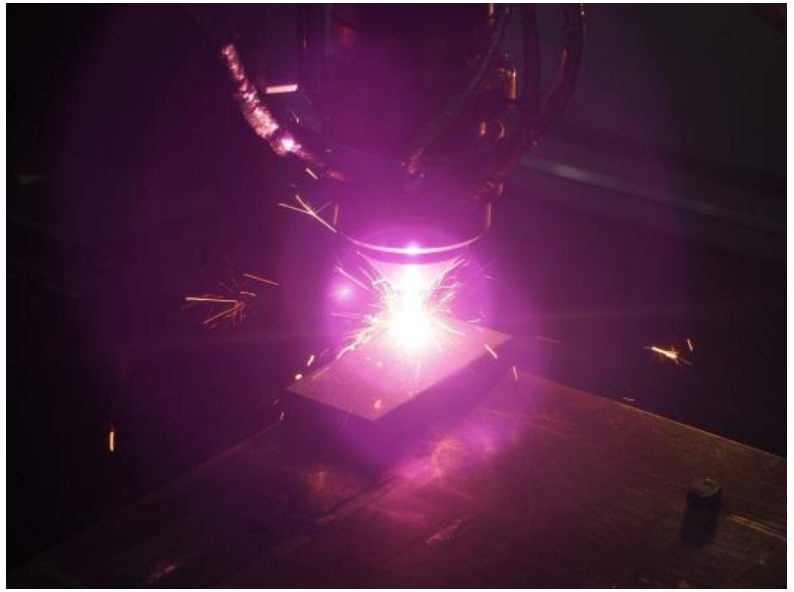
Thermal spray



Flame spray & fuse



Plasma transferred arc



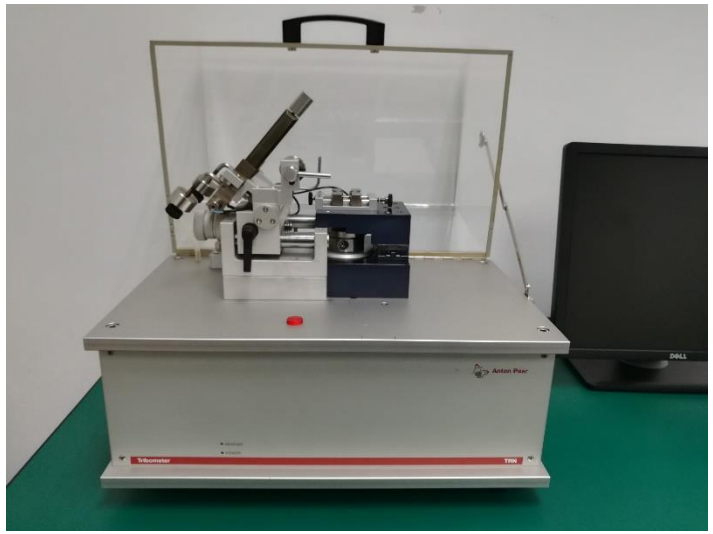
Laser cladding

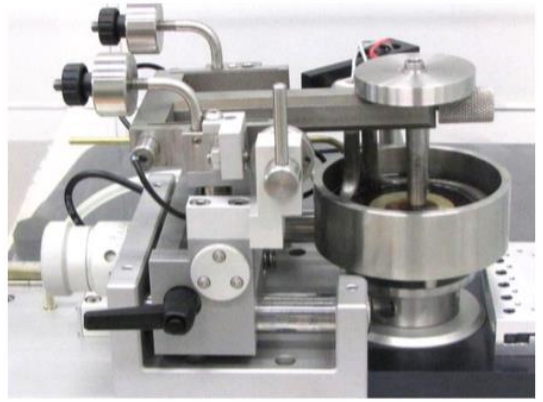
Tribology Tester at Industrial Partner Site

Surface roughness test

Taylor Hobson ultra

V4.6.8

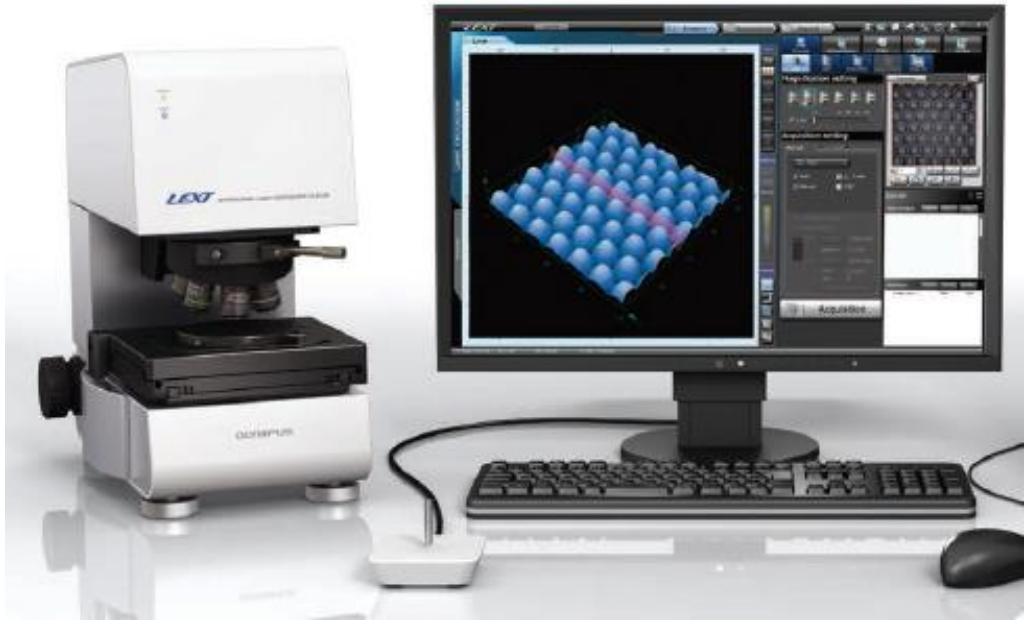




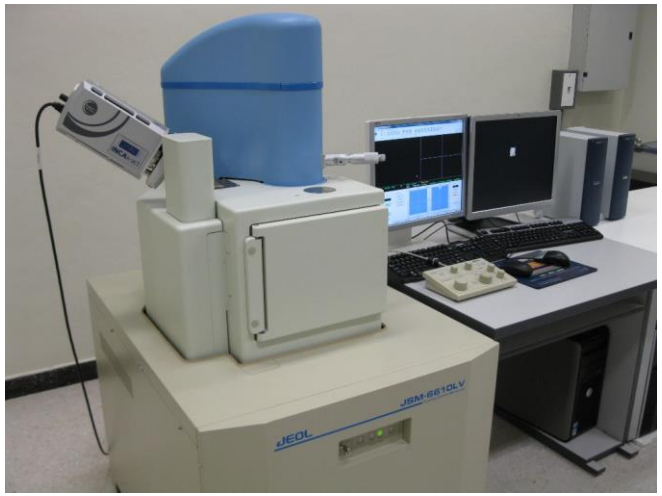
Anton Paar, Tribometer Software version 6.0 x 6.1.x

1. Rotating measurement
   - Single way
   - Reciprocating (angel
2. Linear measurement
3. Rotating Liquid Module & Rotating Heating Liquid Module (Liquid temperature ≤ 150°C)

Surface roughness tester (Non contact type)



Olympus (LEXT OLS4100), Laser scanning



Scanning electron microscope(SEM), JEOL model JSM-6610 LV
Energy dispersive X-ray spectroscopy(EDS),Oxford model INCA350

High temperature Tribometer, CSM Instrument