"THE REWARDS ARE THE CHANGES YOU MAKE TO SOCIETY, NOT YOUR BANK ACCOUNT."

- James van der Walt

การแก้ปัญหาและการสร้างมูลค่าเพิ่ม ให้กับงานวิจัยด้านวัสดุศาสตร์

ผศ.ดร.บุญรัตน์ โล่ห์วงศ์วัฒน
ภาควิชาวิศวกรรมโลหการ คณะวิศวกรรมศาสตร์
จุฬาลงกรณ์มหาวิทยาลัย

CHULA ENGINEERING
Foundation toward Innovation
METALLURGICAL

Contributions

- Classroom and lecture / Invited lectures
- Senior projects
- Master and PhD projects
- Industrial Collaboration
- Spin-off

Boonrat Lohwongwatana

Ph.D. Materials, California Institute of Technology

B.S. Materials Engineering, Northwestern University

Liquidmetal - Startup → IPO 2002 (NASDAQ)

Questek Innovations – Startup M&A by Apple ‘12

Thailand’s Young Technologist Award

Thailand’s Young Metallurgist Award

20+ awards for research & innovation

10+ IP applications / 4 licensing

Advisors

Charles Kuehmann and Greg Olson

“Elon Musk hires Apple’s alloy expert to lead materials engineering at both Tesla and SpaceX” - The Wall Street Journal, December 2015.

Charlie Kuehmann

2012 Director of Product Design, Apple

2016 VP of Materials Engineering @ Tesla and SpaceX

Advisors

Charles Kuehmann and Greg Olson

Prof. Gregory B. Olson

"Father of Materials Design" by the American Academy of Arts and Sciences.

Advisors

Prof. Flemmings and Prof Schuh

MIT

Developer of “Hard tech” – based on materials and processes

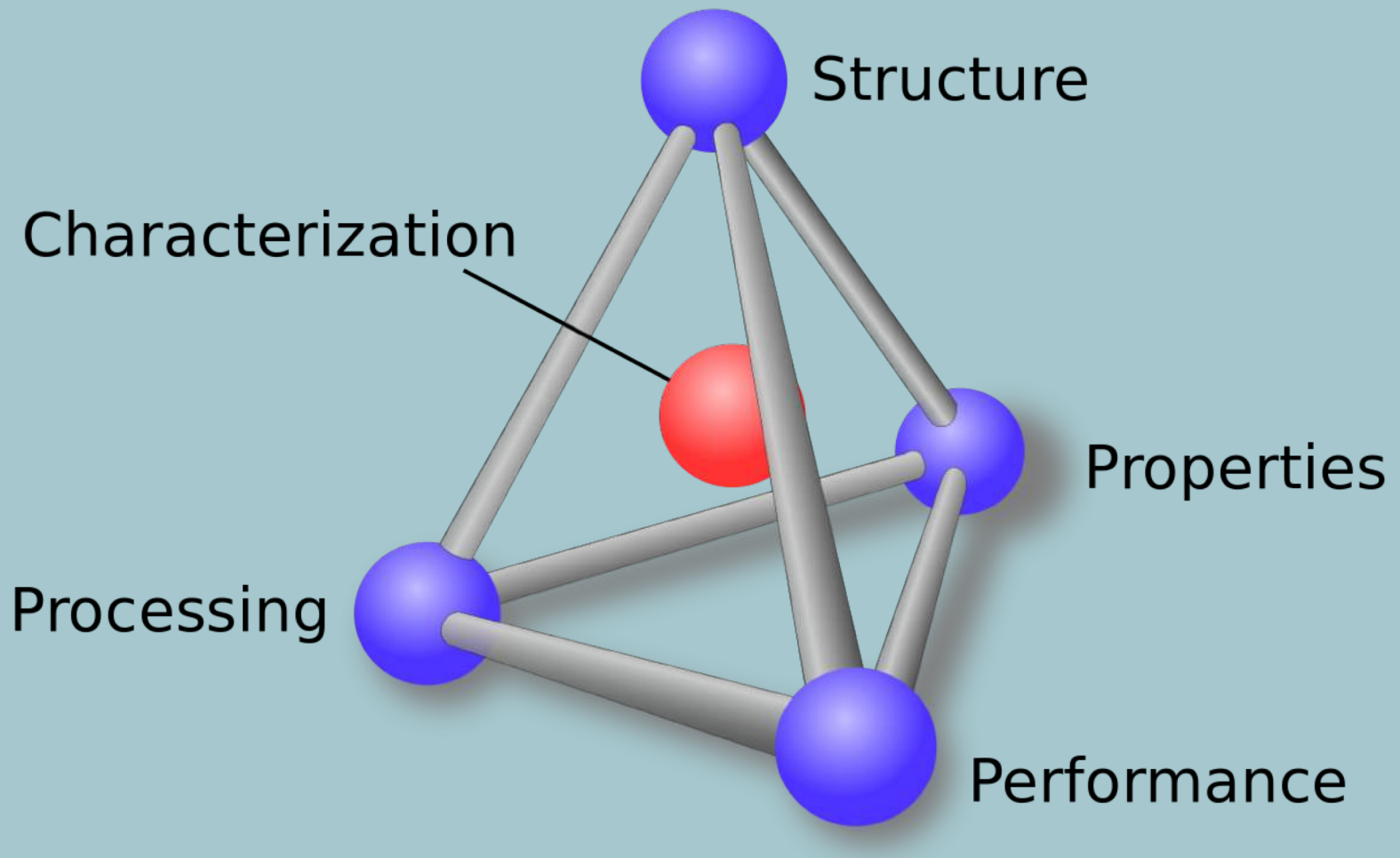
Advisors

Oxford Innovation & **NEWTON FUND**

David Falzani

Royal Academy of Engineering UK

Understanding how material behaves:



By Dhatfield [Public domain], via Wikimedia Commons

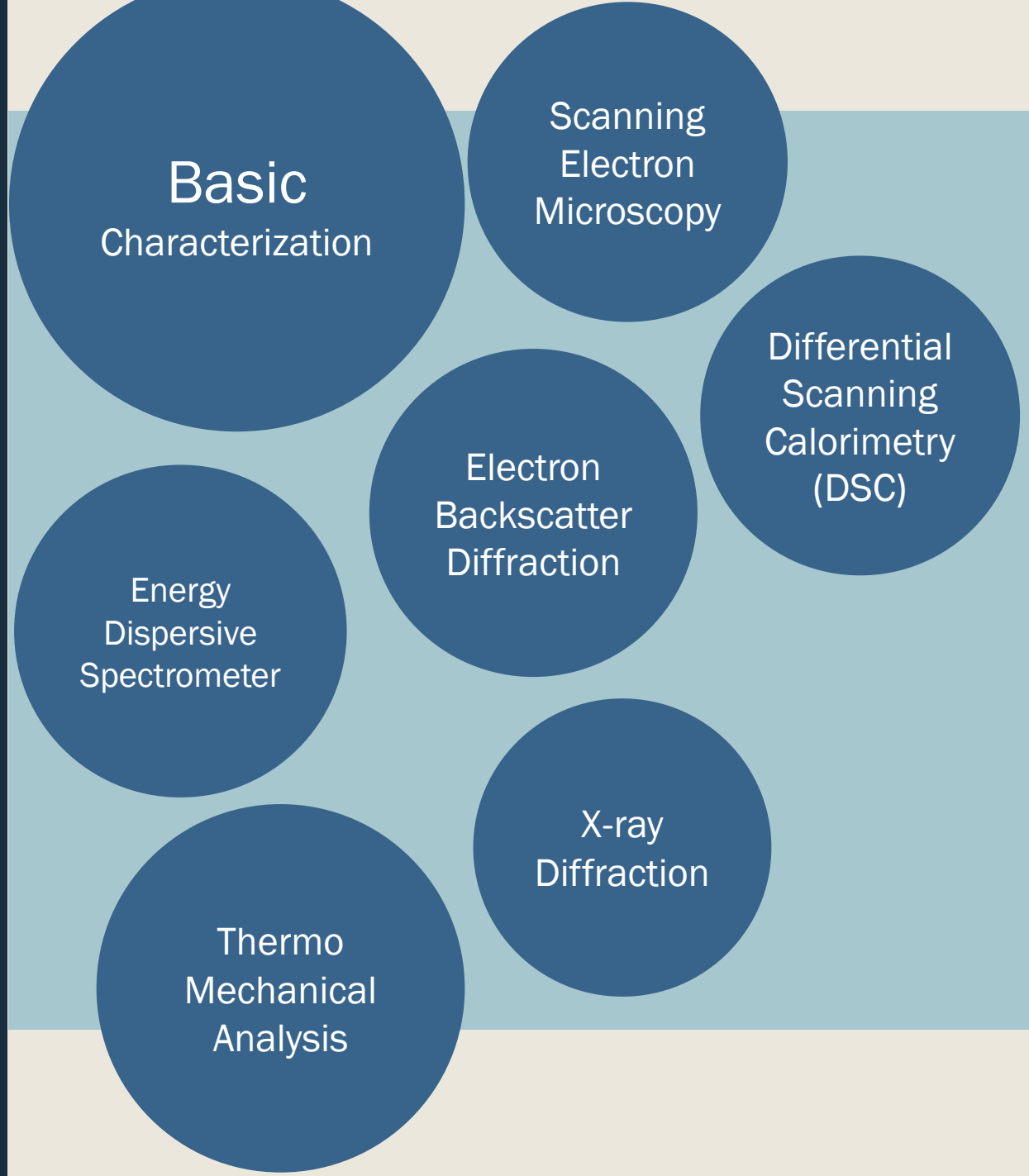
2141303 Materials Characterization

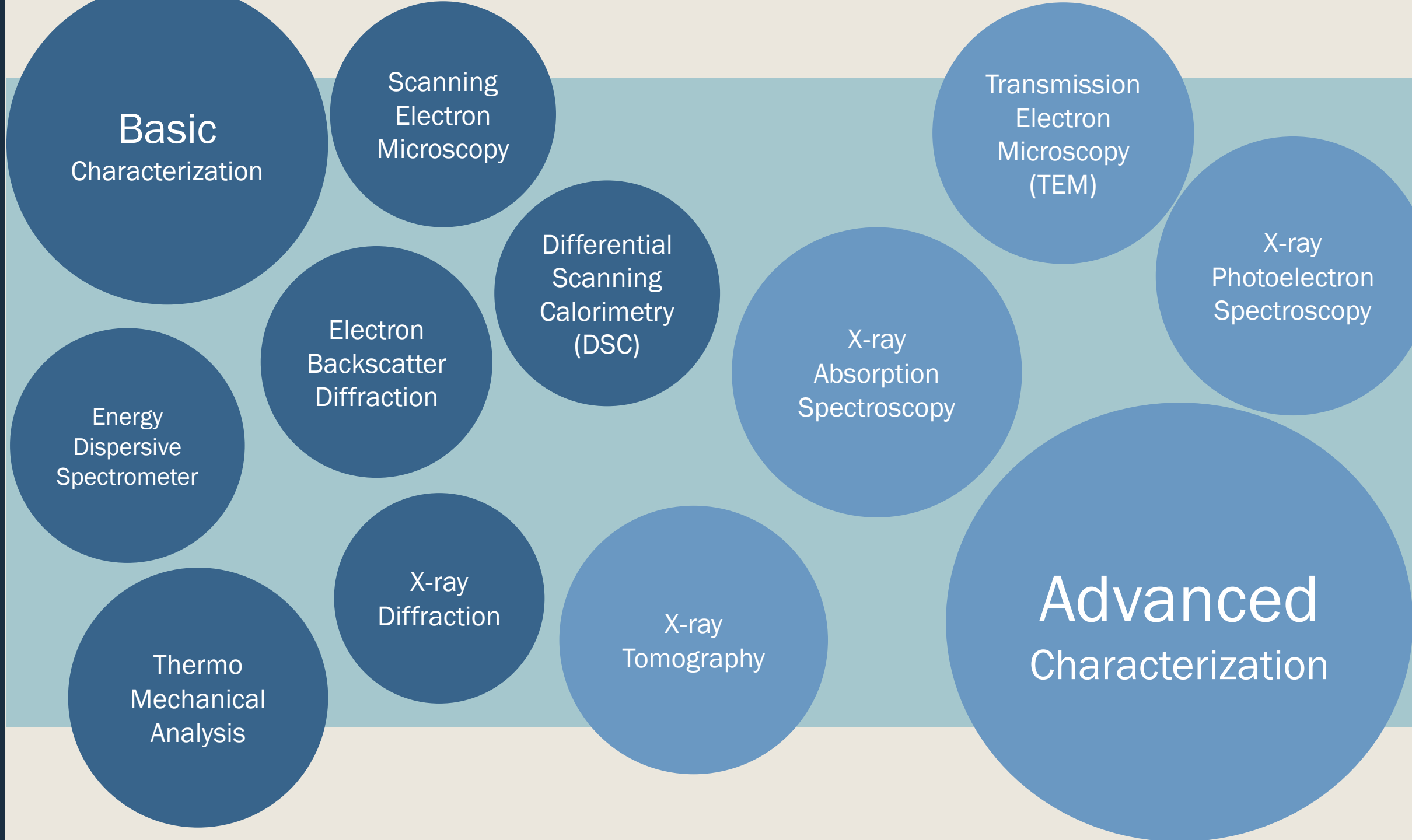
Nano Engineering

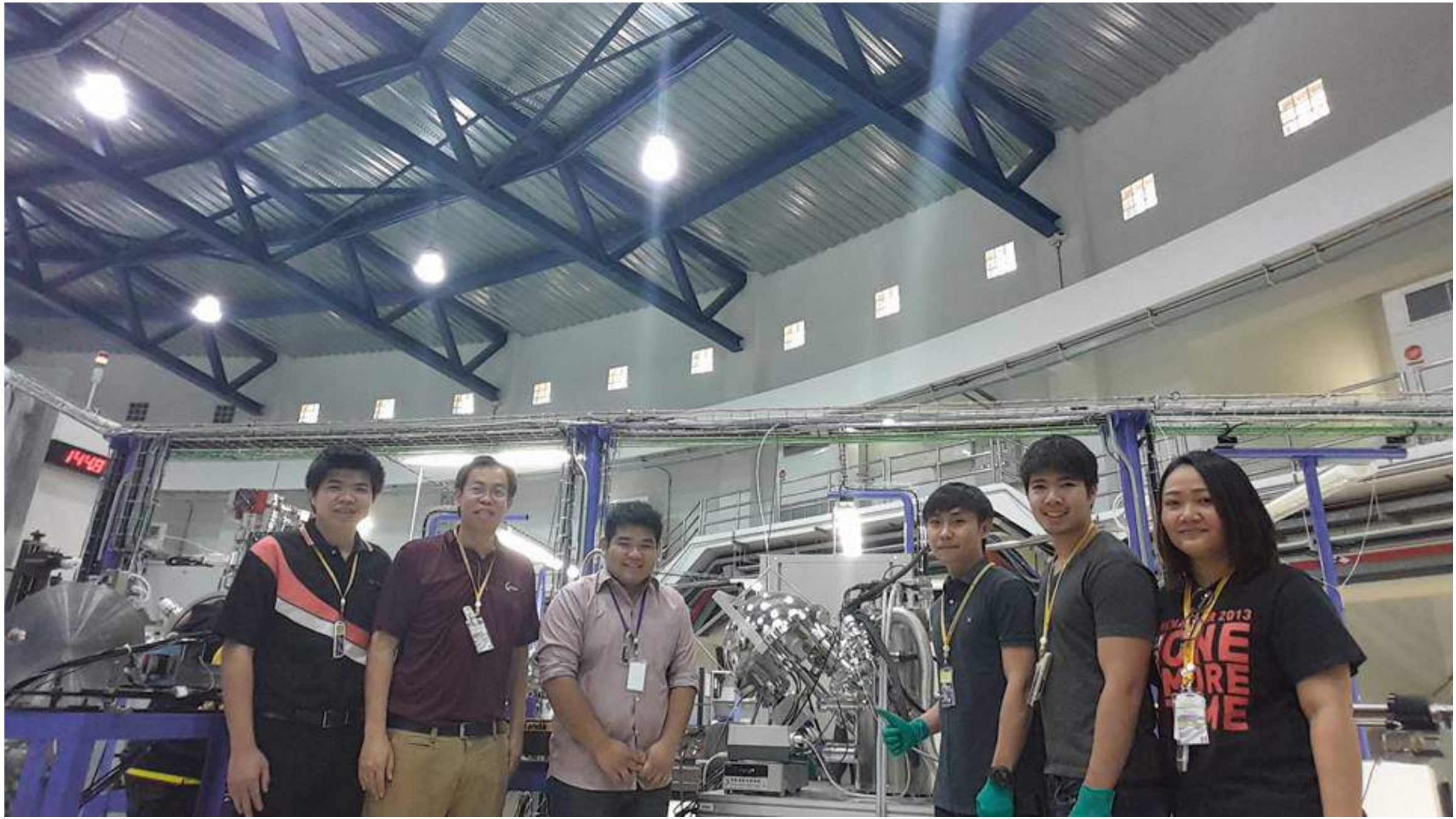
Materials Engineering

Metallurgical Engineering

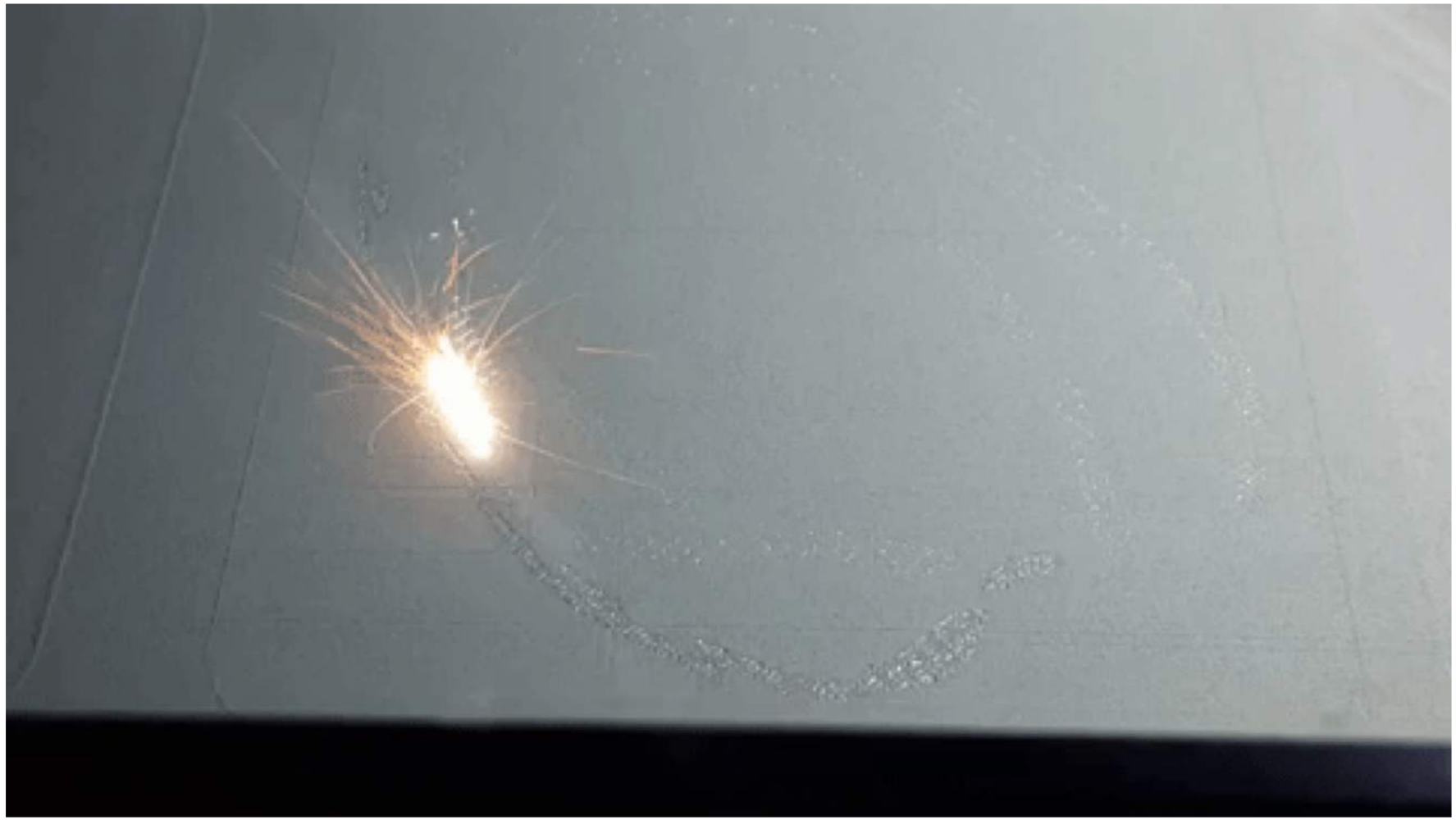
- Optical microscopy,
- Scanning probe microscopy (SPM),
- Field emission scanning electron microscopy (FESEM),
- Transmission electron microscopy (TEM) and Scanning TEM (STEM)
- Focused ion beam (FIB)
- Energy dispersive X-ray spectroscopy (EDS)
- Wavelength Dispersive X-ray spectroscopy (WDS)
- Electron Probe Micro Analysis (EPMA)
- X-ray reflectivity and total reflection X-ray fluorescence, Auger electron spectroscopy (AES)
- X-Ray Photoelectron Spectrometry (XPS)
- Secondary ion mass spectrometry (SIMS)
- Surface secondary ion mass spectrometry extended profile (Surface SIMS XP)
- Time of flight secondary ion mass spectrometry (TOF SIMS)
- LC-MS, GC-MS, IR, FTIR
- Atomic Probe
- Synchrotron techniques


Basic
Characterization
Scanning
Electron
Microscopy
Differential
Scanning
Calorimetry
(DSC)
Electron
Backscatter
Diffraction
Energy
Dispersive
Spectrometer
X-ray
Diffraction
Thermo
Mechanical
Analysis

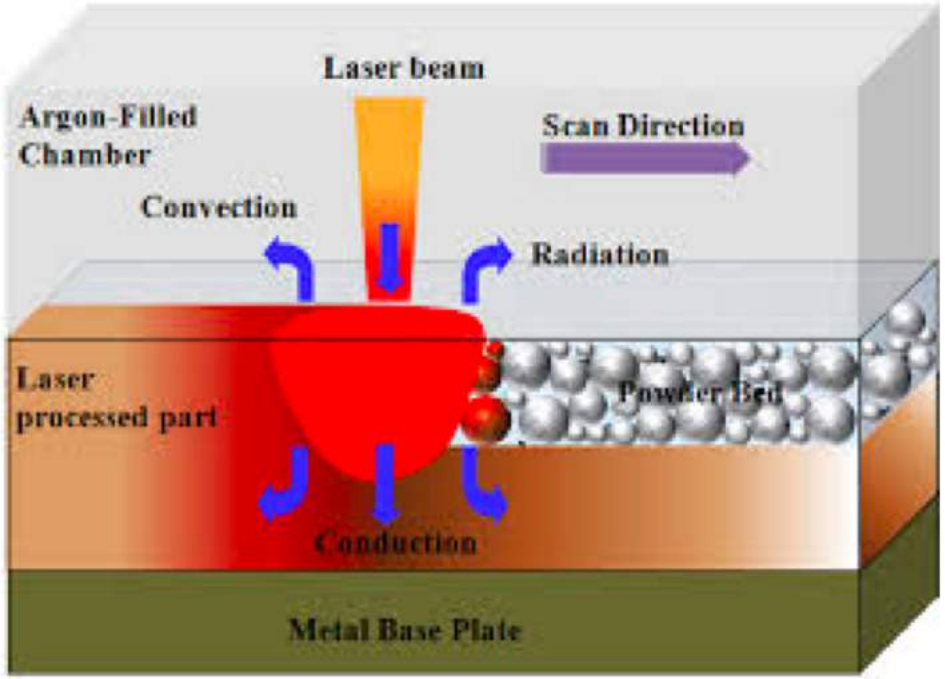

Basic
Characterization
Scanning
Electron
Microscopy
Transmission
Electron
Microscopy
(TEM)
X-ray
Photoelectron
Spectroscopy
Differential
Scanning
Calorimetry
(DSC)
Electron
Backscatter
Diffraction
X-ray
Absorption
Spectroscopy
Energy
Dispersive
Spectrometer
X-ray
Diffraction
X-ray
Tomography
Thermo
Mechanical
Analysis
Advanced
Characterization

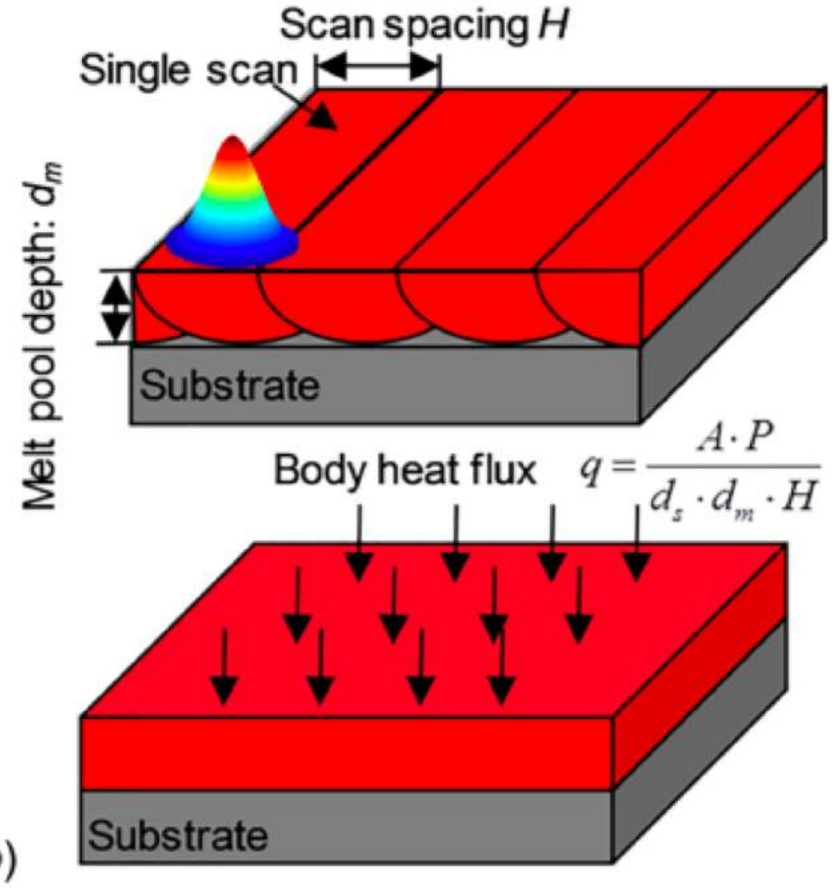


3D Printing

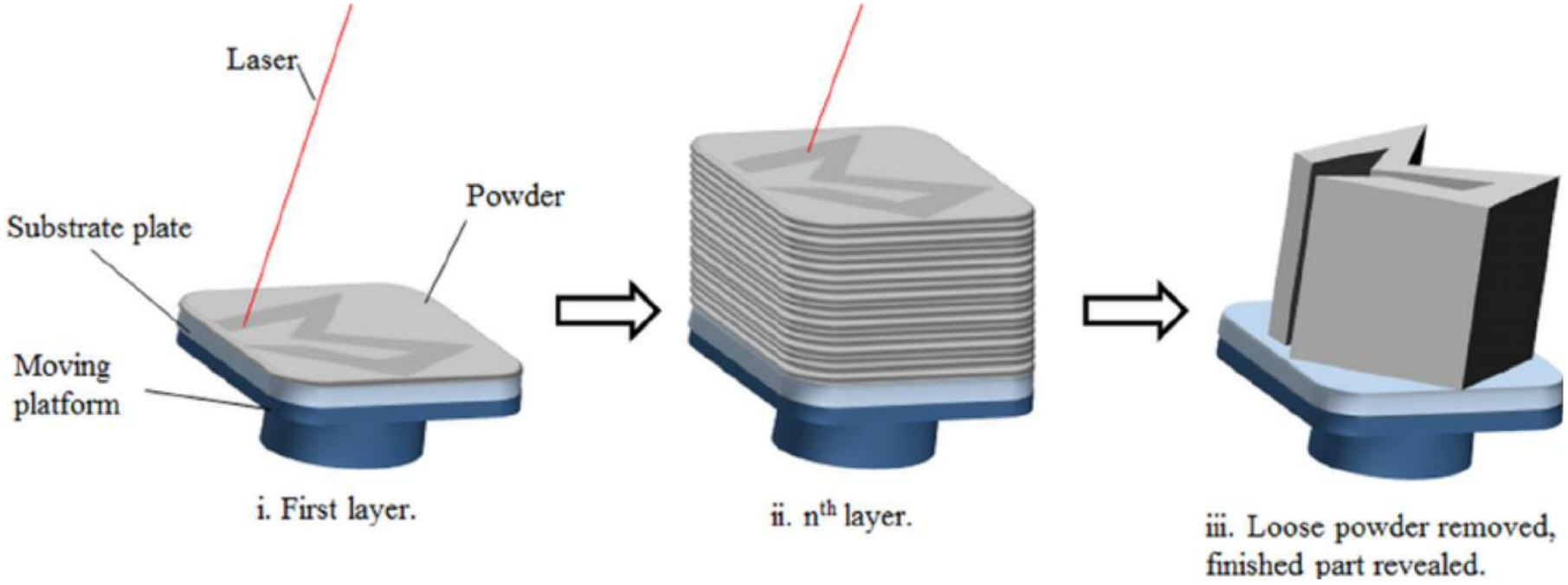


State-of-the-Art Powder bed fusion



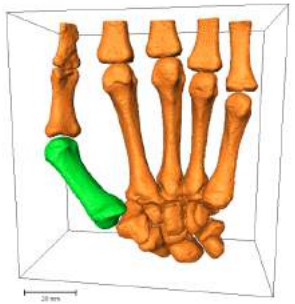


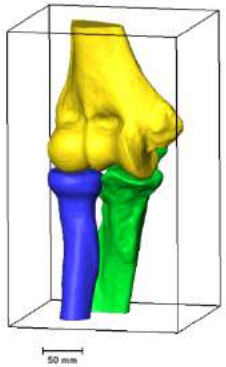
State-of-the-Art Powder bed fusion

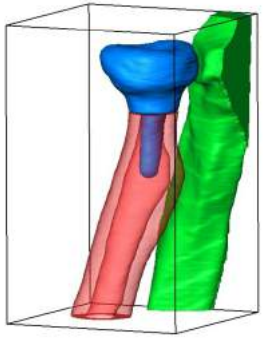


3D Printing

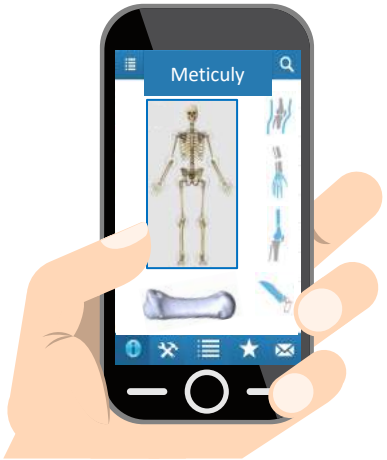
Customised Titanium Implant using 3D Printing







Each titanium implant is specifically designed based on the patient's CT scan to match precisely to the 3D model of the bone. Then the model is checked for biomechanics and finally created using 3D printing technology.

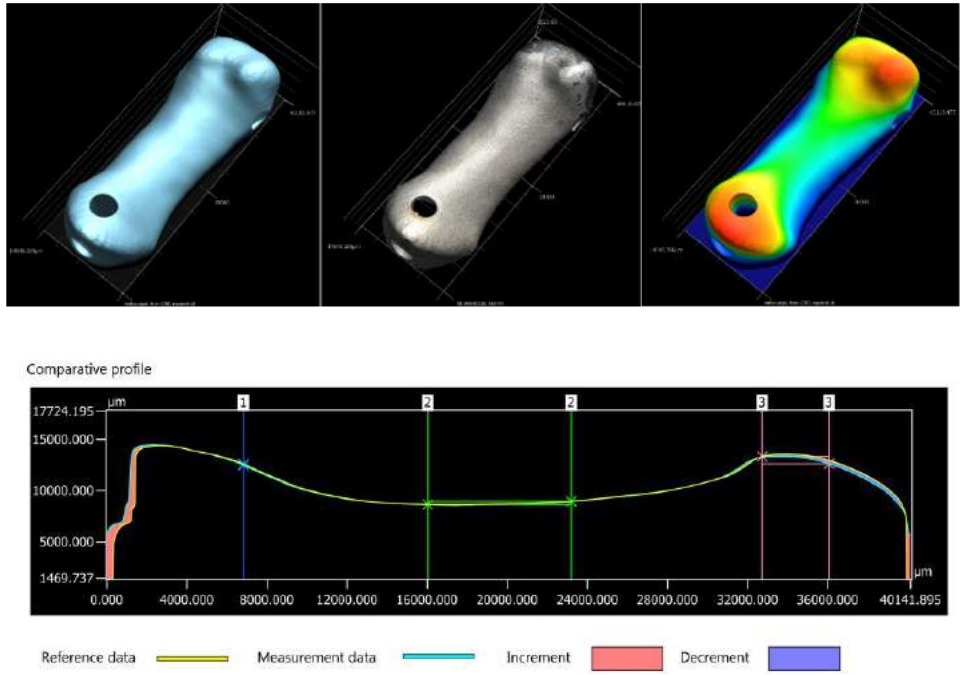


CHULA ENGINEERING METALLURGICAL

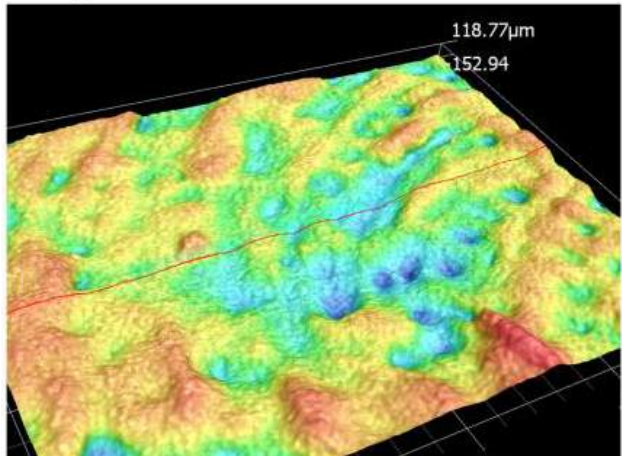
METICULY

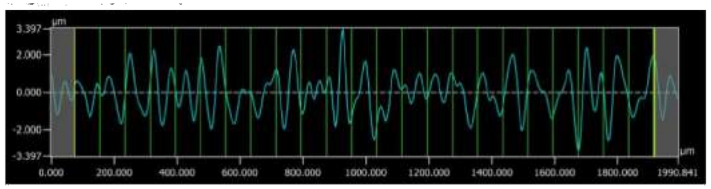
Quality control

- Dimension accuracy



- Surface Roughness





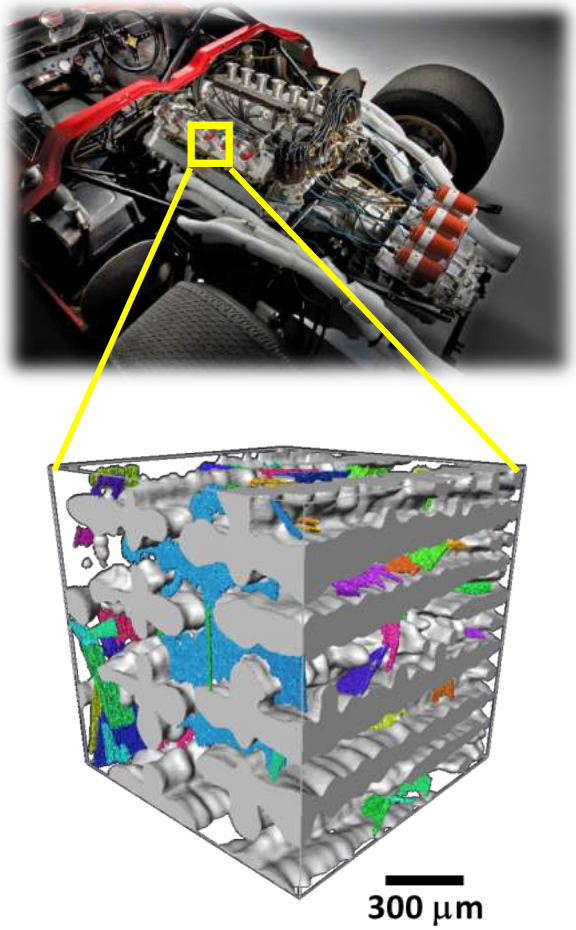
Surface roughness is approximately 1 um

Industrial Research

Characterisation of internal structures via 3D imaging

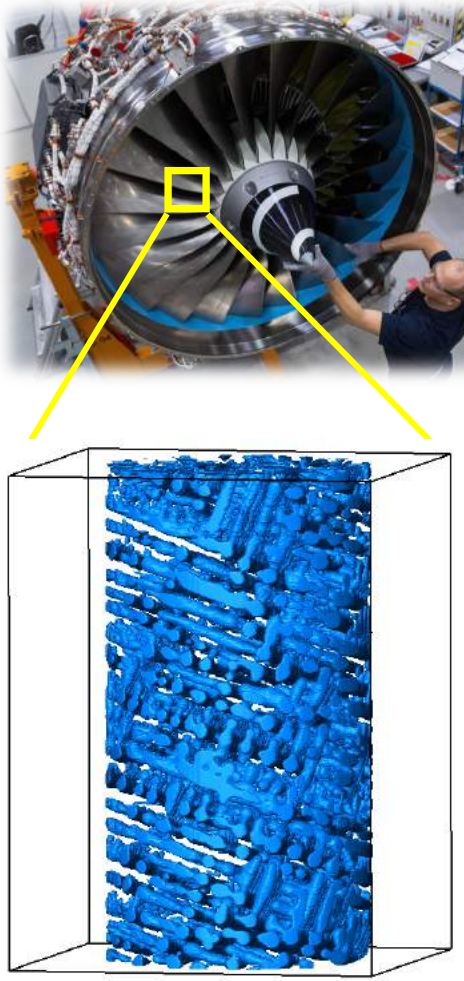
Aluminium alloys

for automotive components



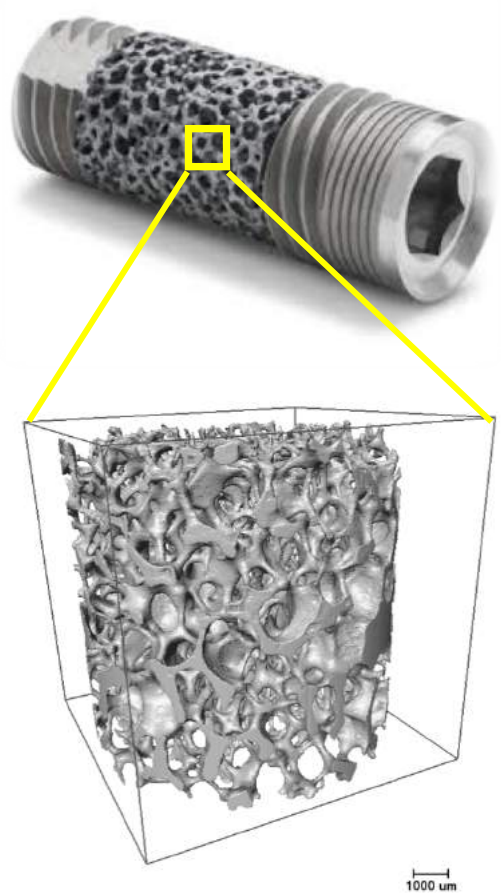
Nickel alloys

for high-temperature applications



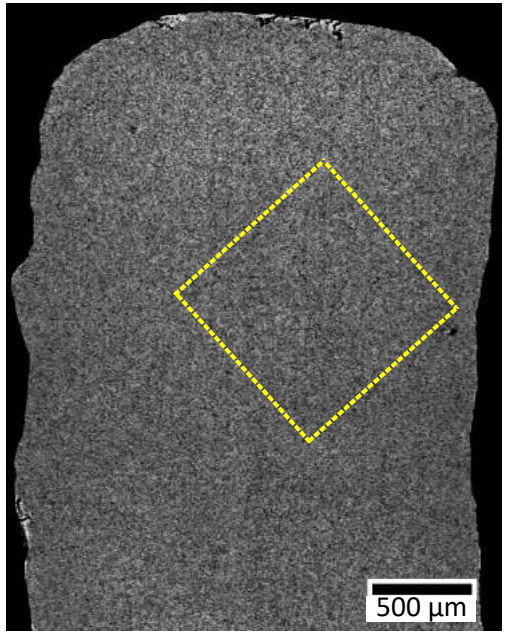
Titanium alloys

for medical implants

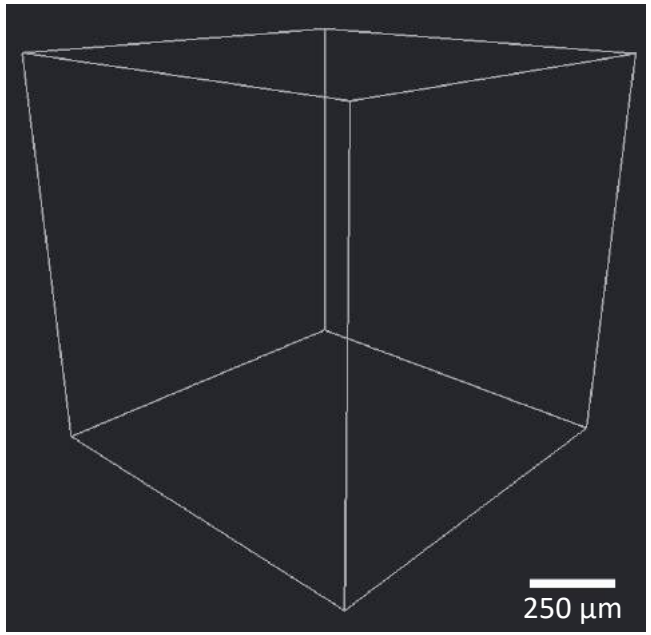


Combining experimental observation with numerical simulation to better understand casting defect

Real-time observation during solidification of Al-Si-Cu alloys

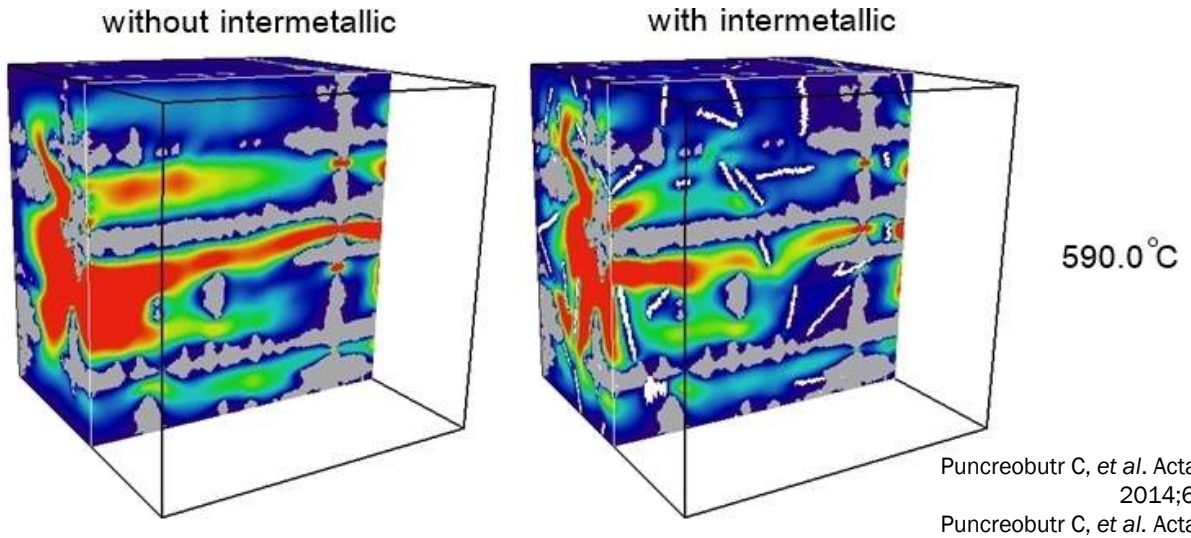


Cross-sectional Microstructure



Rendered 3D Structures

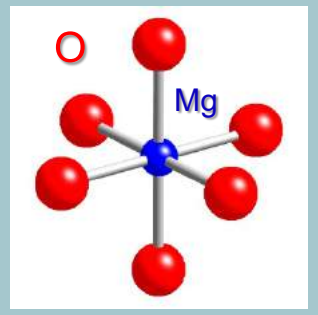
3D Imaging + CFD modelling



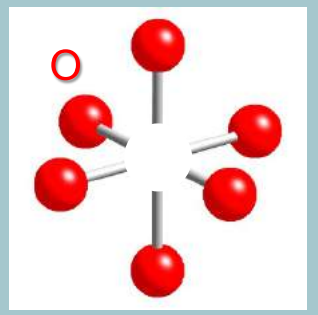
Puncreobutr C, *et al*. Acta Mater 2014;64:316.
Puncreobutr C, *et al*. Acta Mater 2014;79:292.

Effect of Mg vacancy on magnetic properties of MgO

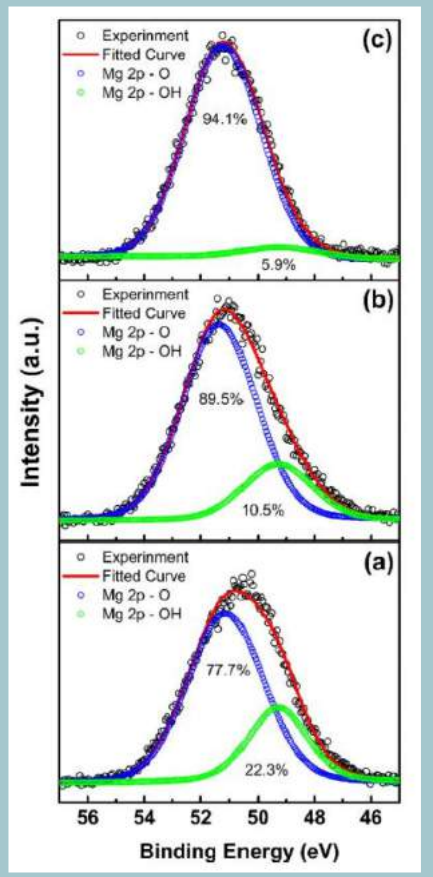
Diamagnetic



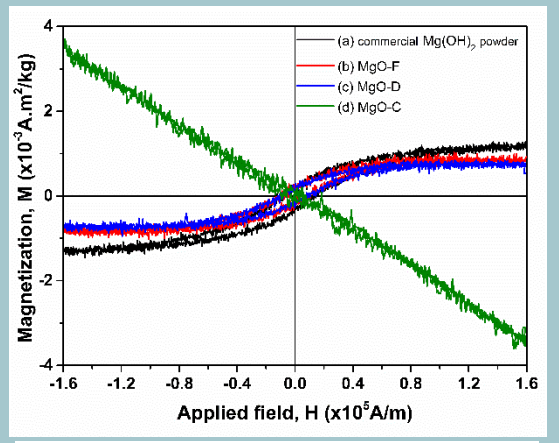
Ferromagnetic

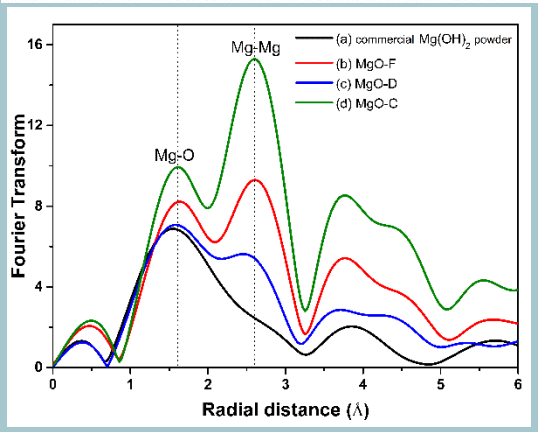


XPS
Surface analysis



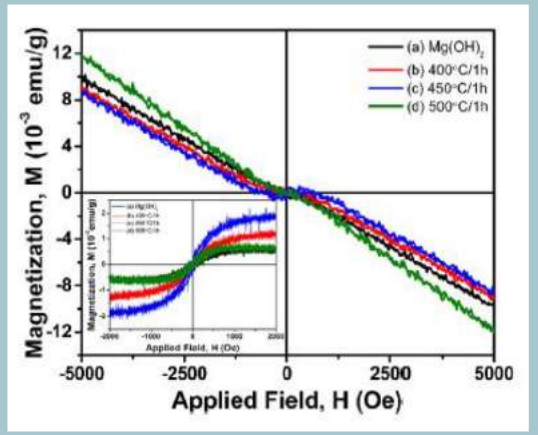
XAS analysis

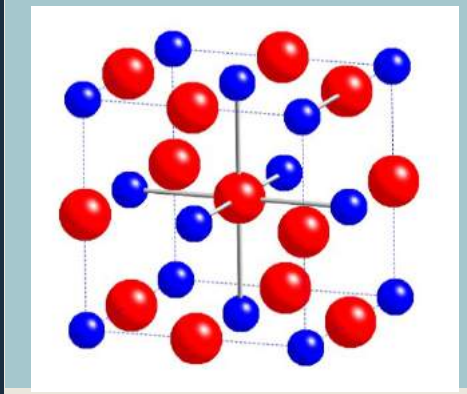




MgO (Barrier layer) in HDD

- ❑ Diamagnetic material
- ❑ Good insulator





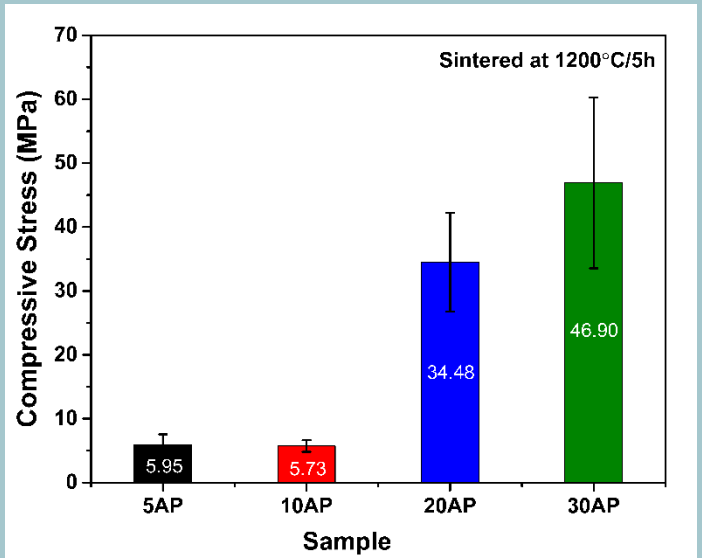
MgO structure

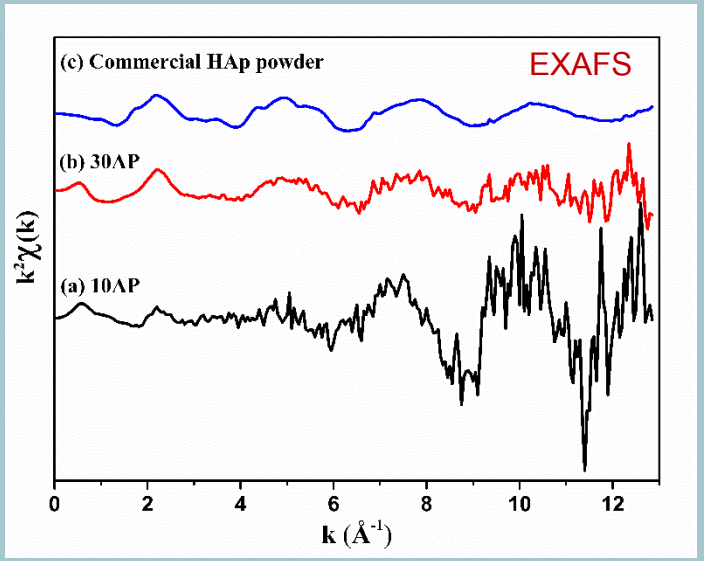
Journal of Alloys and Compounds, 2017, Impact factor = 3.133, Q1

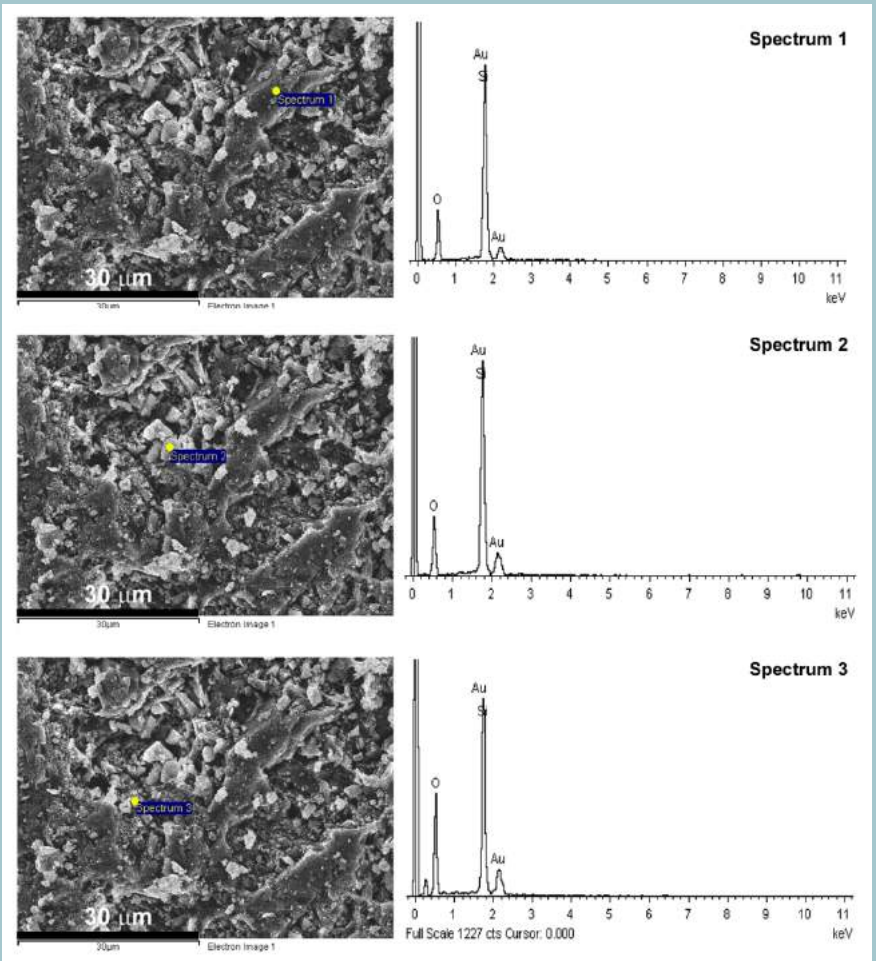
Journal of Magnetism and Magnetic Materials, 2018, Impact factor = 2.630, Q1

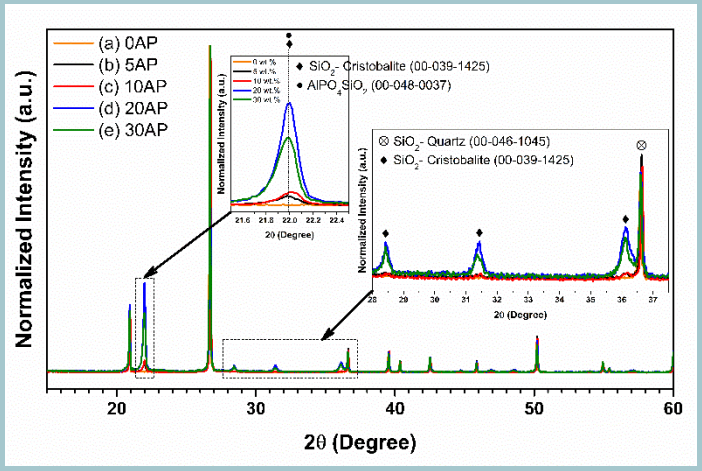
Effect of phosphate compound on physical and mechanical properties of SiO_2 ceramic

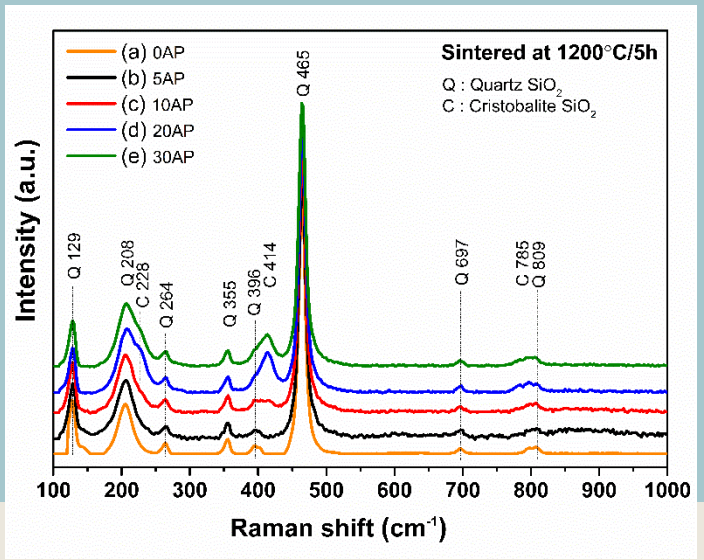
(Ceramics International)







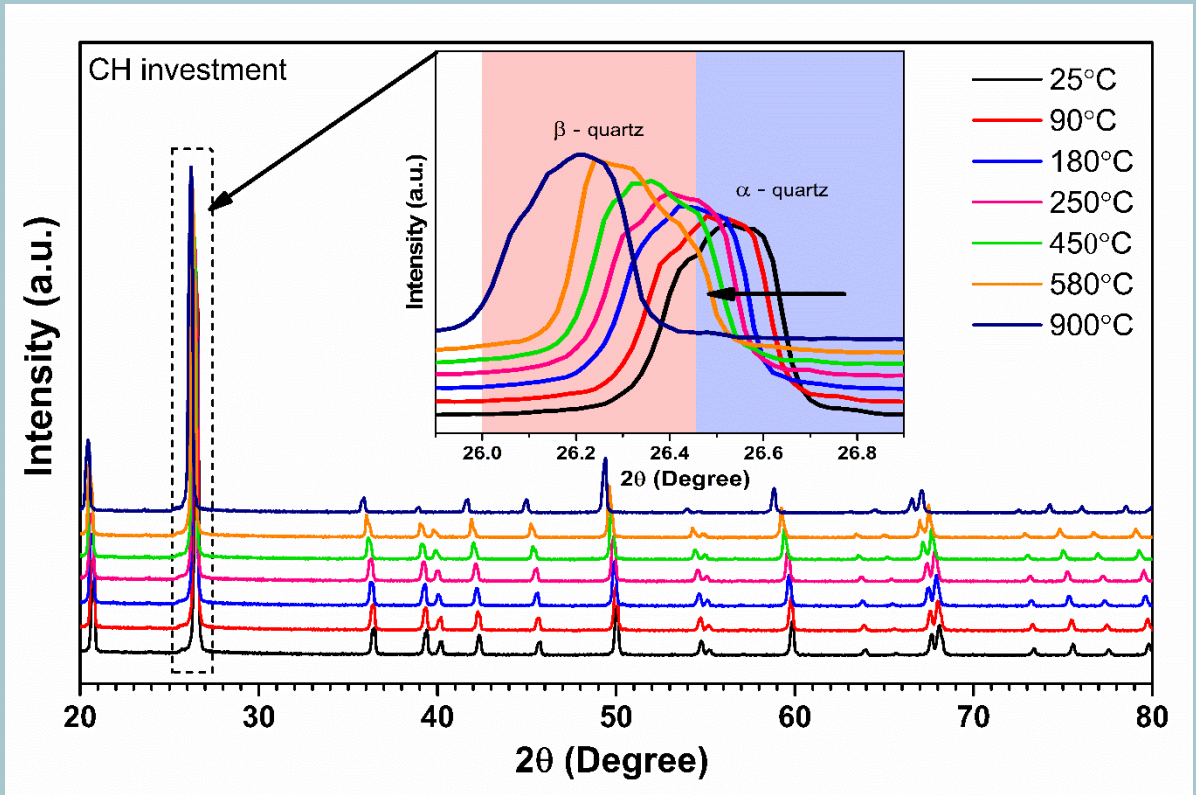


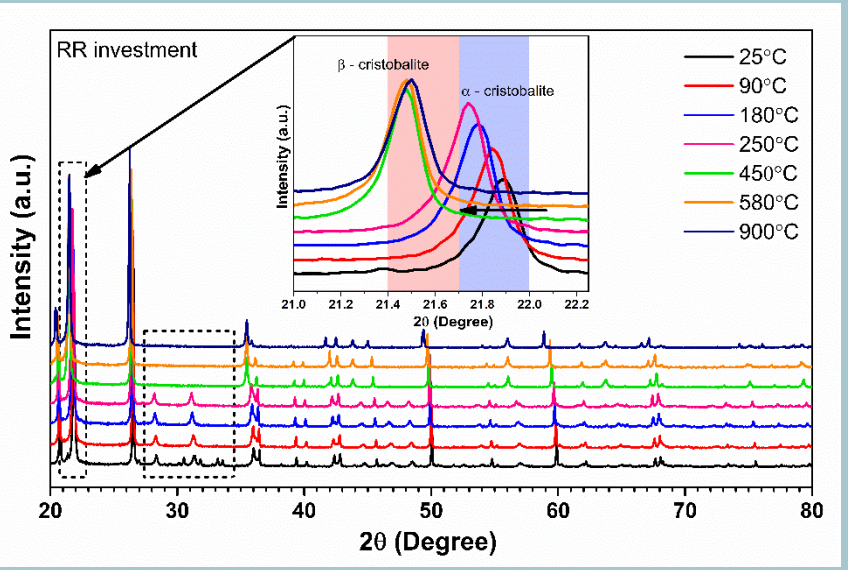


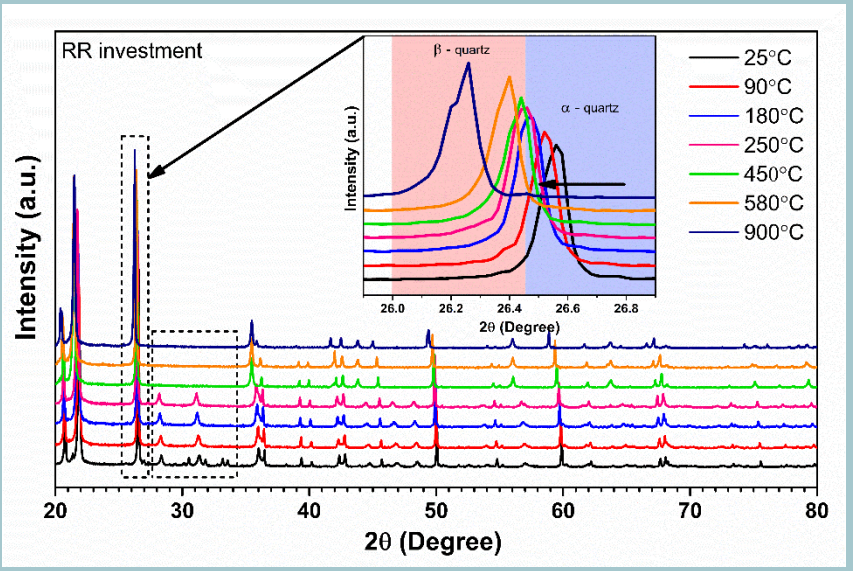
Atchara Khamkongkaeo, Ph. D.

Thermo characteristic of investment mold for high melting point alloy casting

- CH investment → Quartz SiO_2
- RR investment → Cristobalite and Quartz SiO_2



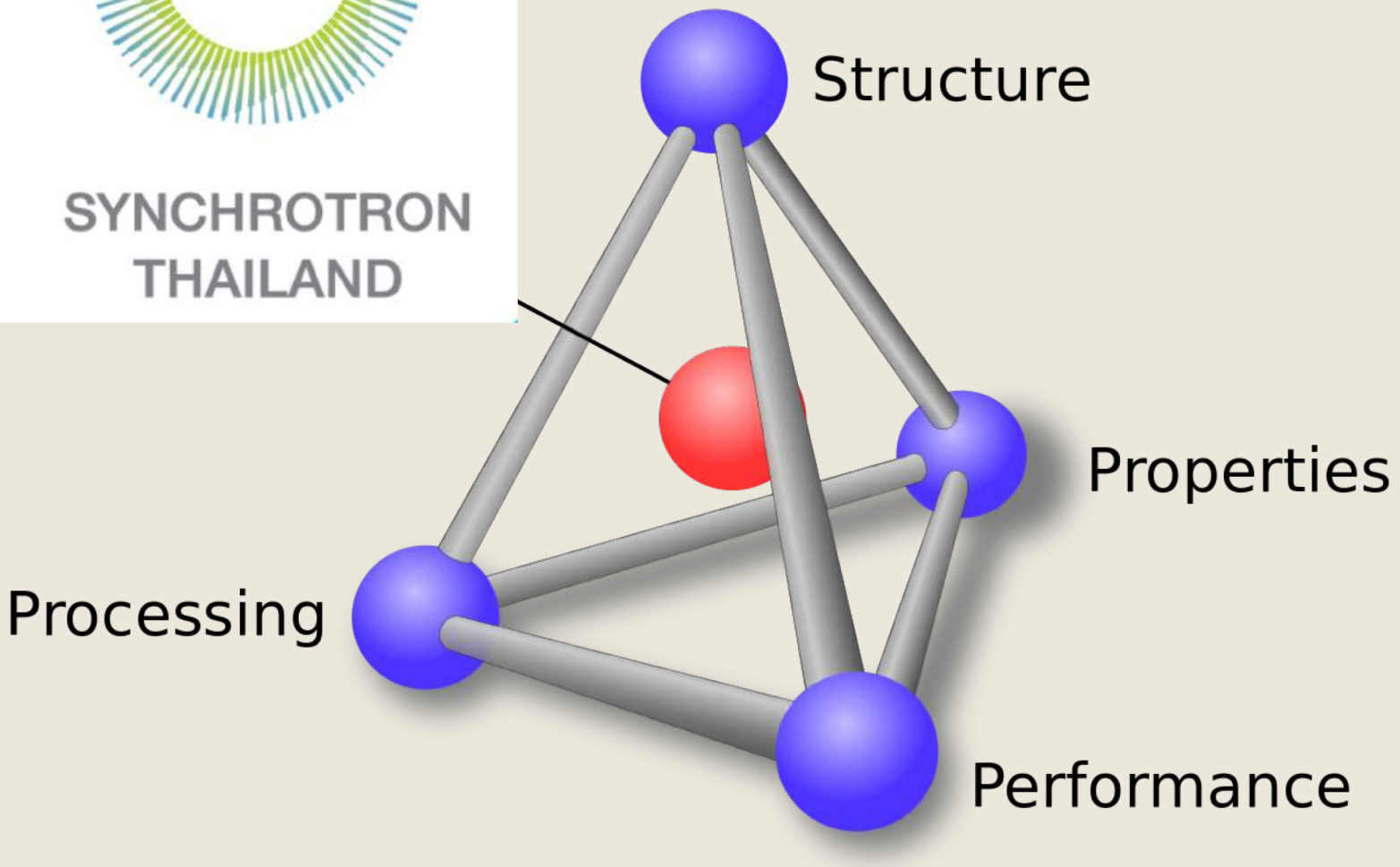




Phase transformation → Volume changed → Mechanical properties changed

SYNCHROTRON THAILAND

Thank you



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