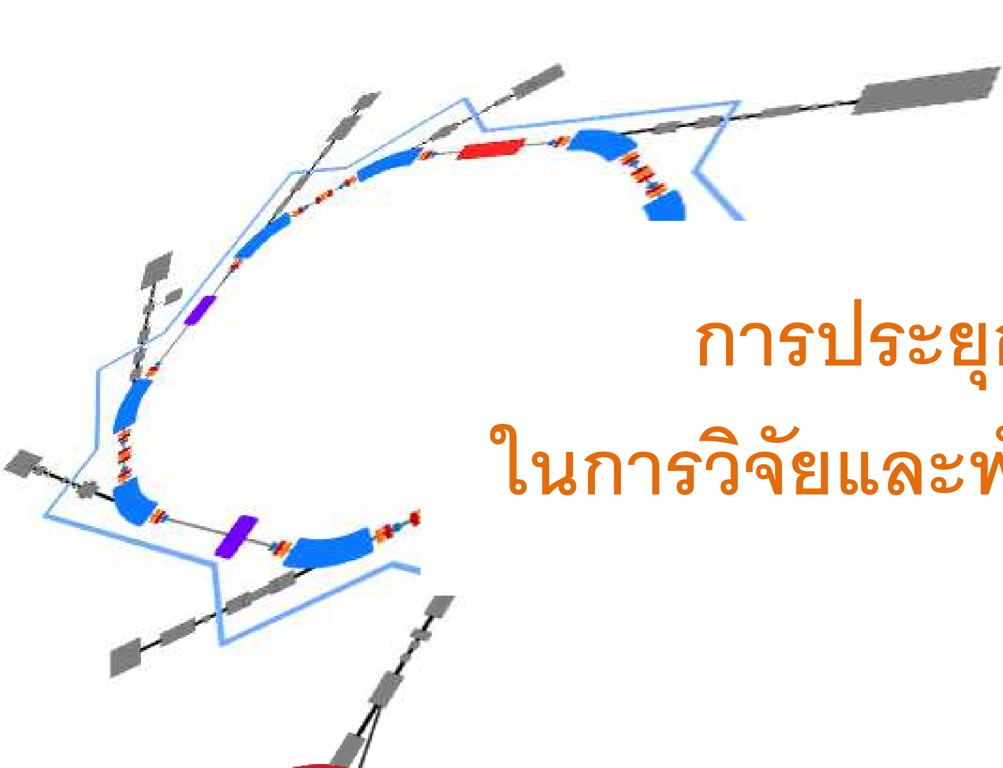
Synchrotron Light Research Institute

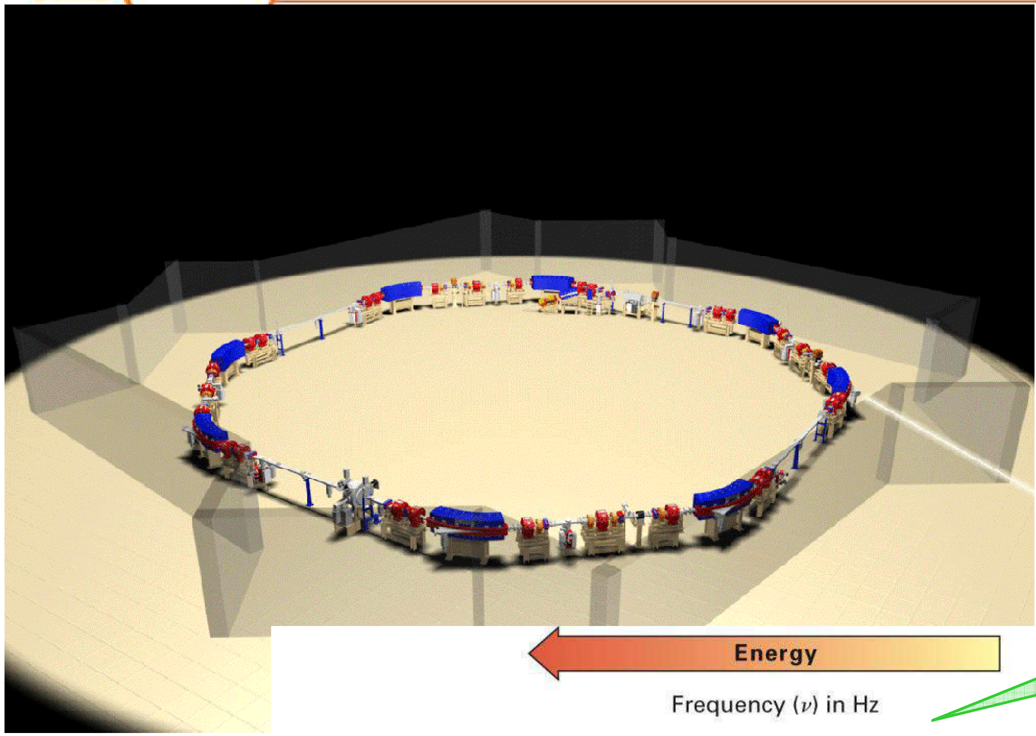


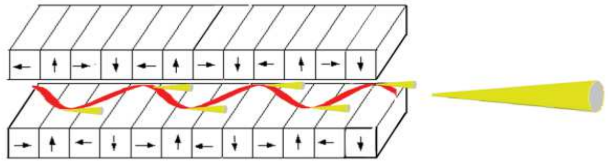
การประยุกต์แสงซินโครตรอน ในการวิจัยและพัฒนาด้านนาโนเทคโนโลยี

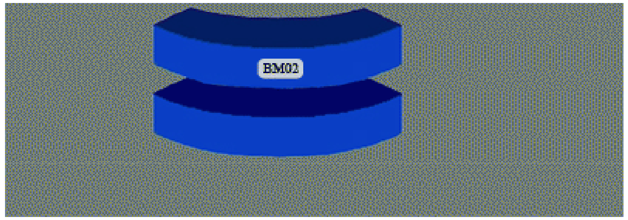
Pinit Kidkhunthod (Ph.D. Physics)

Beamline scientist at BL5.2 XAS
Synchrotron Light Research Institute
Nakhon Ratchasima, THAILAND
email : pinit@slri.or.th

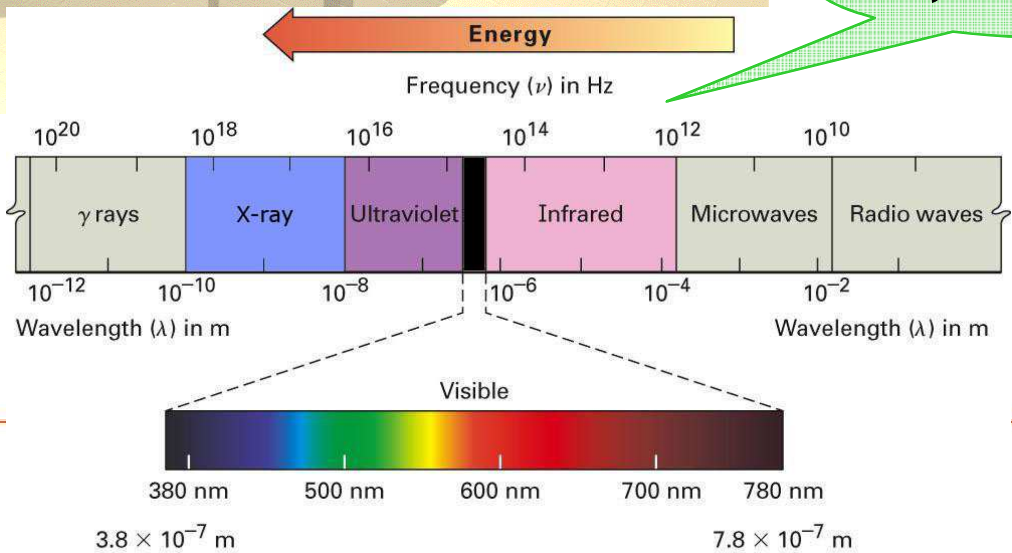
How to produce Synchrotron Light?

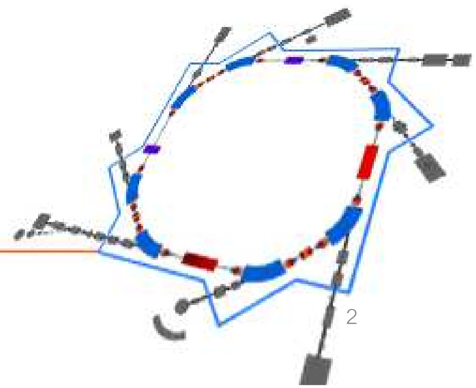




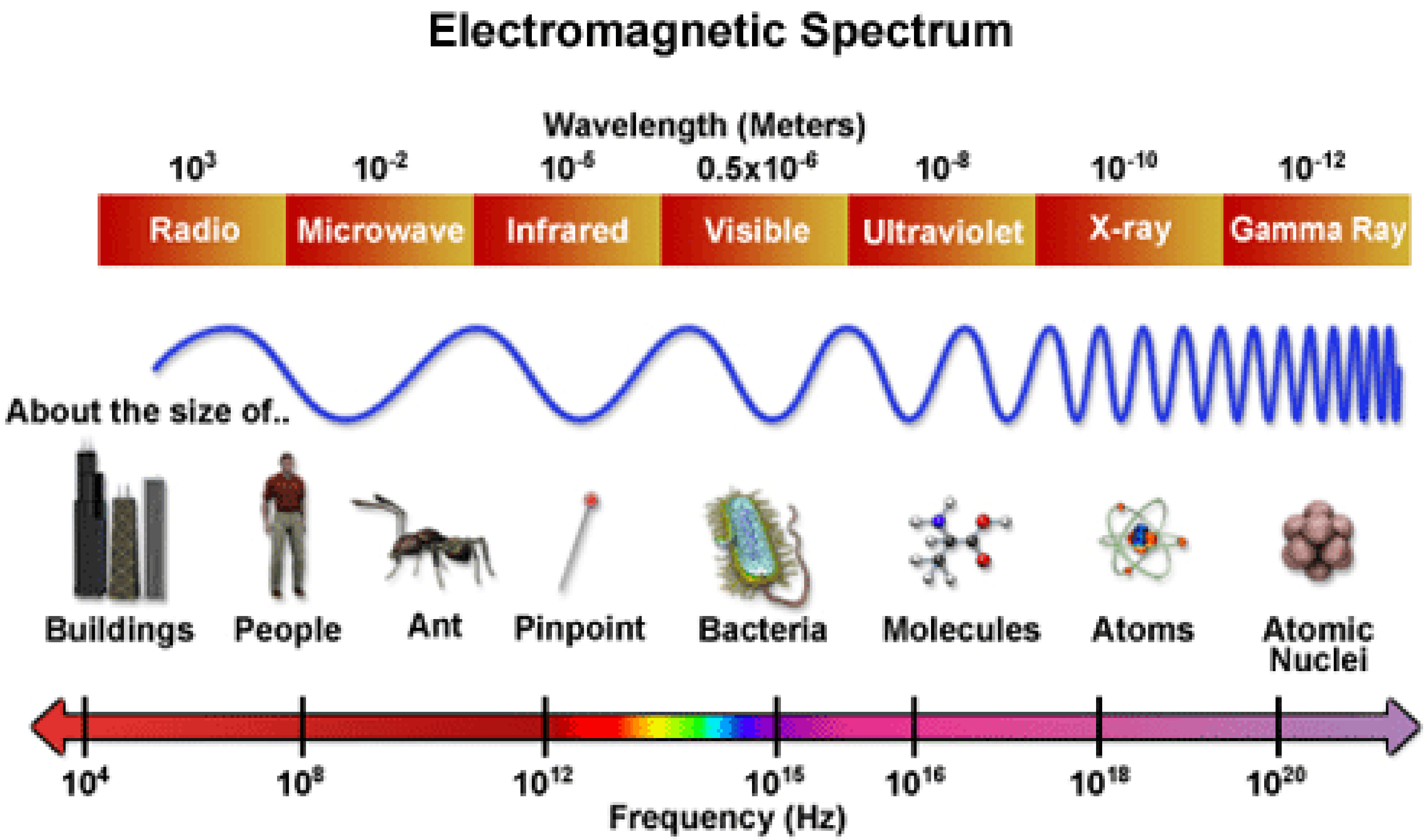


Synchrotron Light

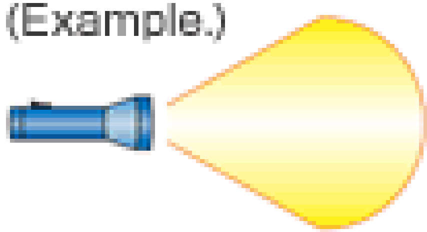
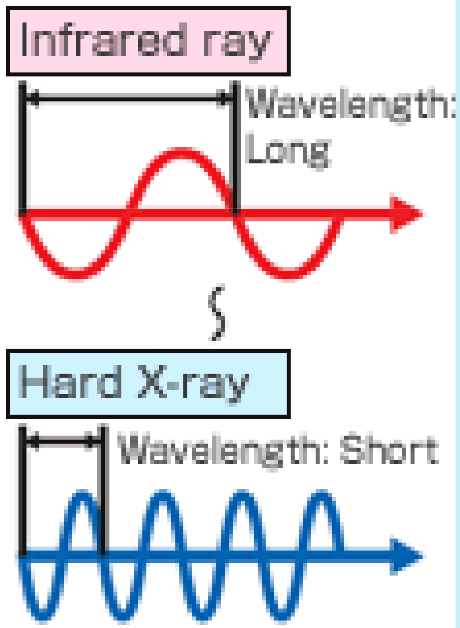




Electromagnetic Spectrum



Why do we need Synchrotron Light?

Very bright	Narrowly focused and does not spread (High directionality)	Includes a broad wavelength range from infrared to hard X-rays
Synchrotron radiation  10 billions times sunlight Sunlight	Synchrotron radiation  Narrowly focused Flashlight' s beam (Example.)  The beam spreads	
Rapid analysis Trace element analysis	Mapping with nano engineering	Chemical state analysis Local structure analysis

www.astf-kha.jp

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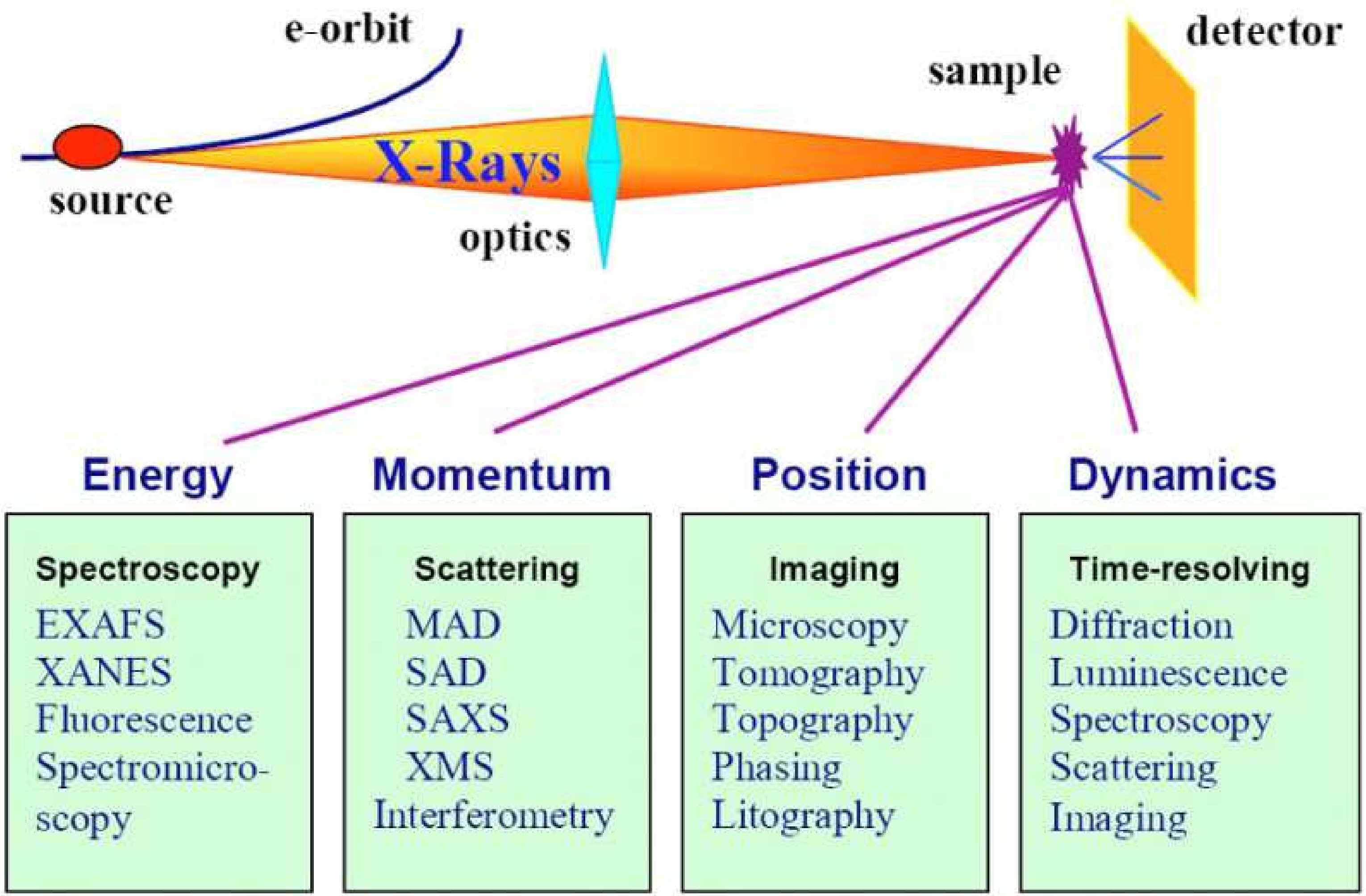
Synchrotron-based Techniques



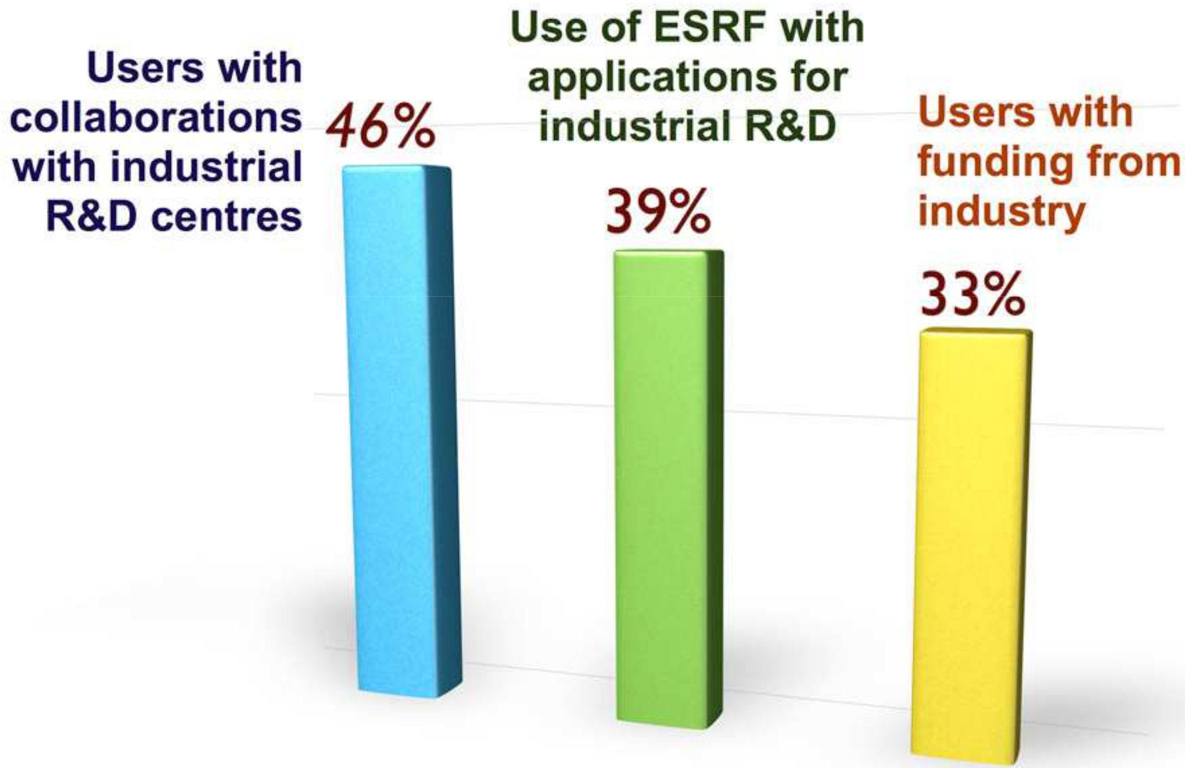
candle.am

Synchrotron Light Research Institute

SR-Applications in Industrial Works :

www.lightsource.ca

ESRF Case for Industrial Works

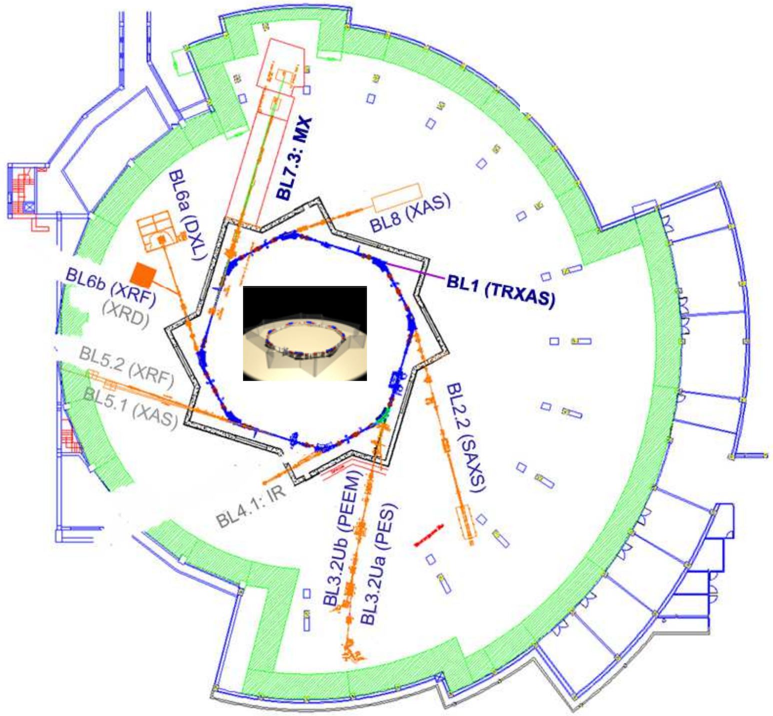


www.esrf.eu

Beamlines at SLRI, THAILAND

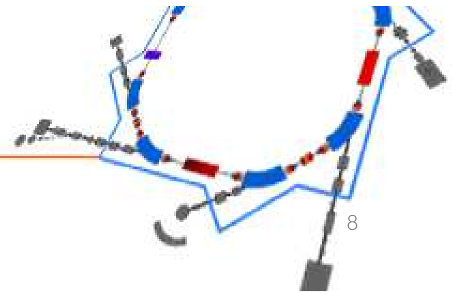
In Operation :

- BL1.3 : SAXS : Small Angle X-ray Scattering
- BL2.2: TR-XAS : Timed-resolved XAS
- BL3.2a: PES : Photoelectron Emission Spectroscopy
- BL3.2b: PEEM : Photoemission Electron Microscopy
- BL5.2: SUT-NANOTEC-SLRI XAS beamline
- BL6a: DXL : Deep X-ray Lithography
- BL6b: micro-XRF : X-ray Fluorescence
- BL7.2: MX (Protein Crystallography)
- BL8: XAS : X-ray Absorption Spectroscopy



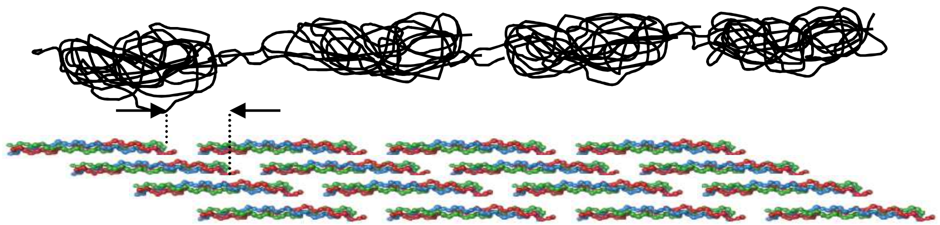
In Commissioning

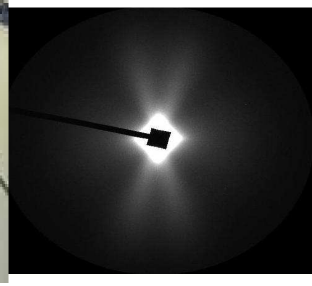
- BL4.1: IR Spectroscopy & Imaging

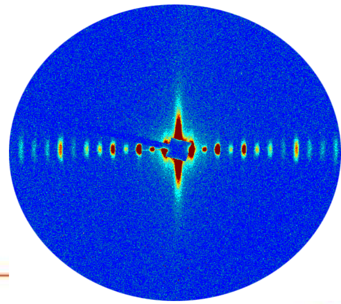


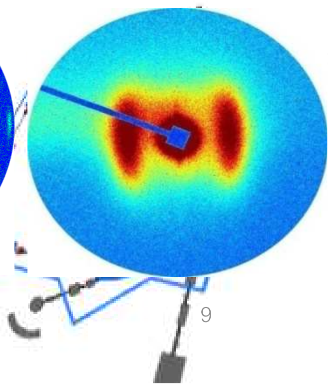
BL1.3 : SAXS : Small Angle X-ray Scattering

- *ขนาดและรูปร่างของอนุภาคที่มีขนาดในช่วงประมาณ -100 นาโนเมตร*
- *โครงสร้างระดับนาโน และการจัดเรียงตัวของโมเลกุลในวัสดุ เช่น precipitation in metal, พอลิเมอร์หรือเส้นใย*







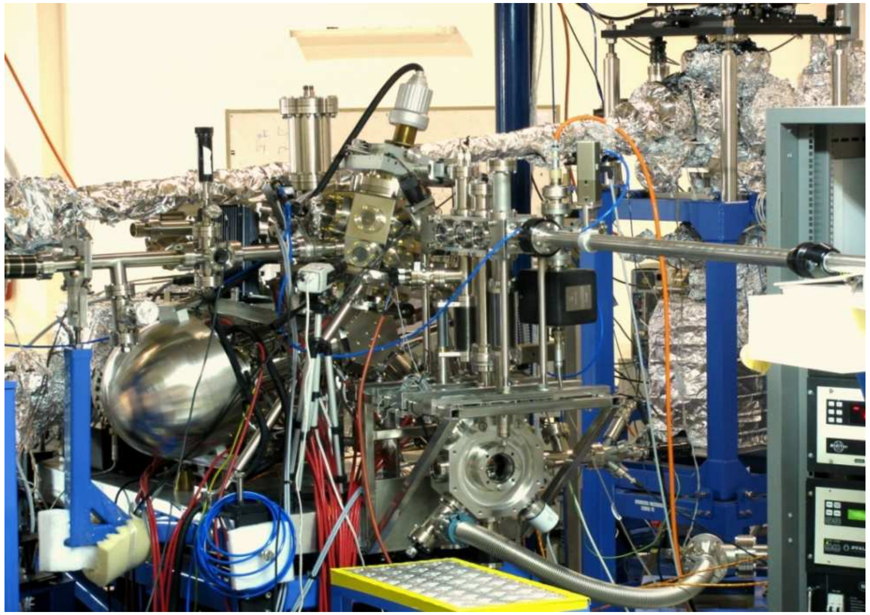


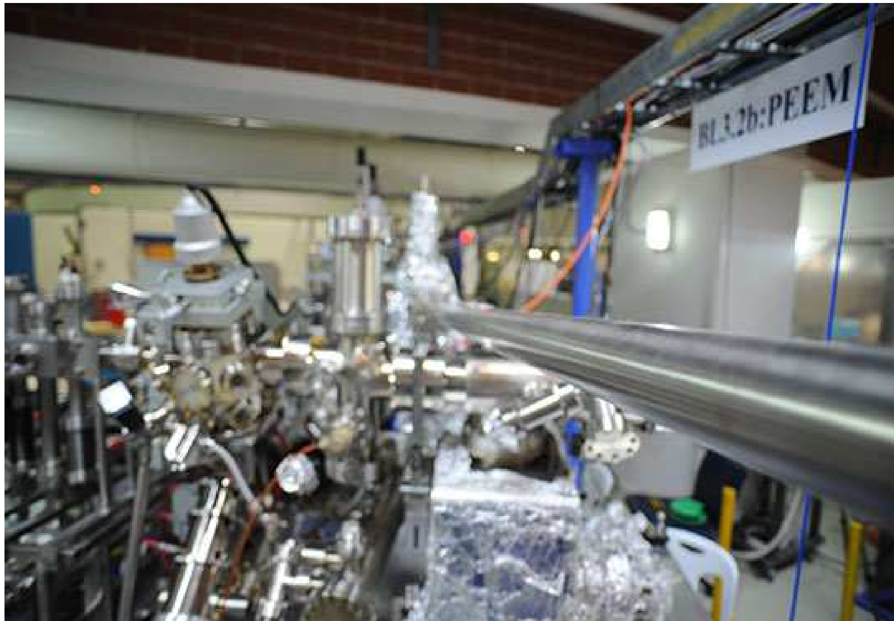
BL3.2a: PES: Photoelectron Emission Spectroscopy

สำหรับการศึกษาวิจัยสมบัติของวัสดุ โดยเฉพาะวัสดุที่มีขนาดระดับนาโนเมตร เพื่อศึกษาคุณลักษณะของพื้นผิว และรอยต่อของชั้นผิววัสดุ ธาตุบนพื้นผิวของสารตัวอย่าง และยังใช้ในการวัดสมบัติความเป็นแม่เหล็กของสารตัวอย่างอีกด้วย

BL3.2b: PEEM: Photoelectron Emission Microscopy

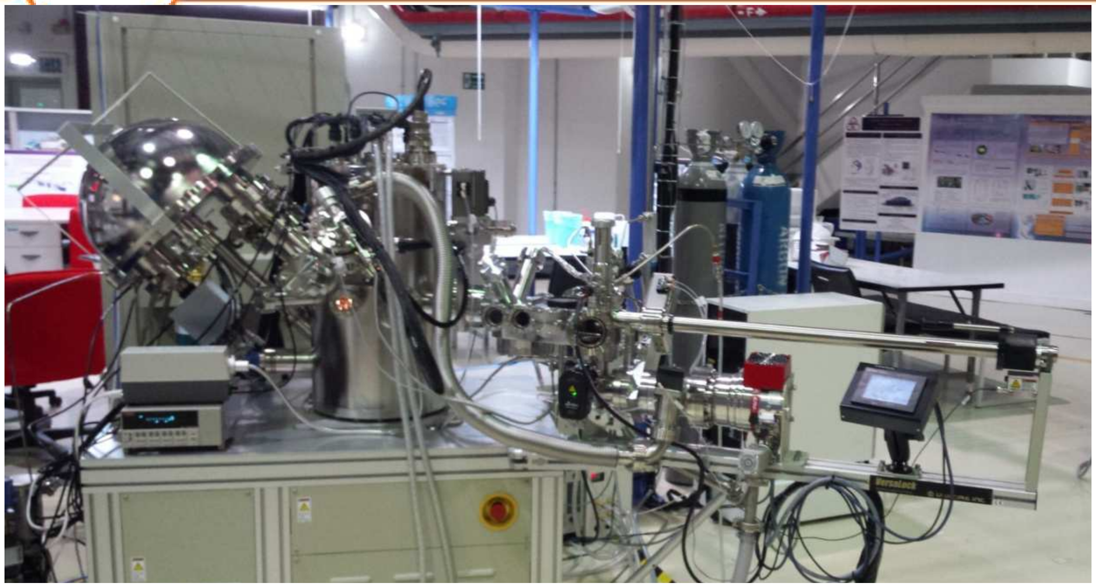
เป็นเทคนิควิเคราะห์ที่มีประสิทธิภาพสูง และมีประโยชน์สำหรับงานศึกษาด้านพื้นผิว และการปลูกฟิล์มบาง เนื่องจากสามารถเลือกถ่ายภาพบริเวณที่สนใจบนผิวของตัวอย่างได้โดยมีความละเอียดในระดับนาโนเมตร นอกจากนี้ยังสามารถเลือกวิเคราะห์องค์ประกอบทางเคมี และโครงสร้างทางผลึกของวัตถุบนผิวของสารตัวอย่าง





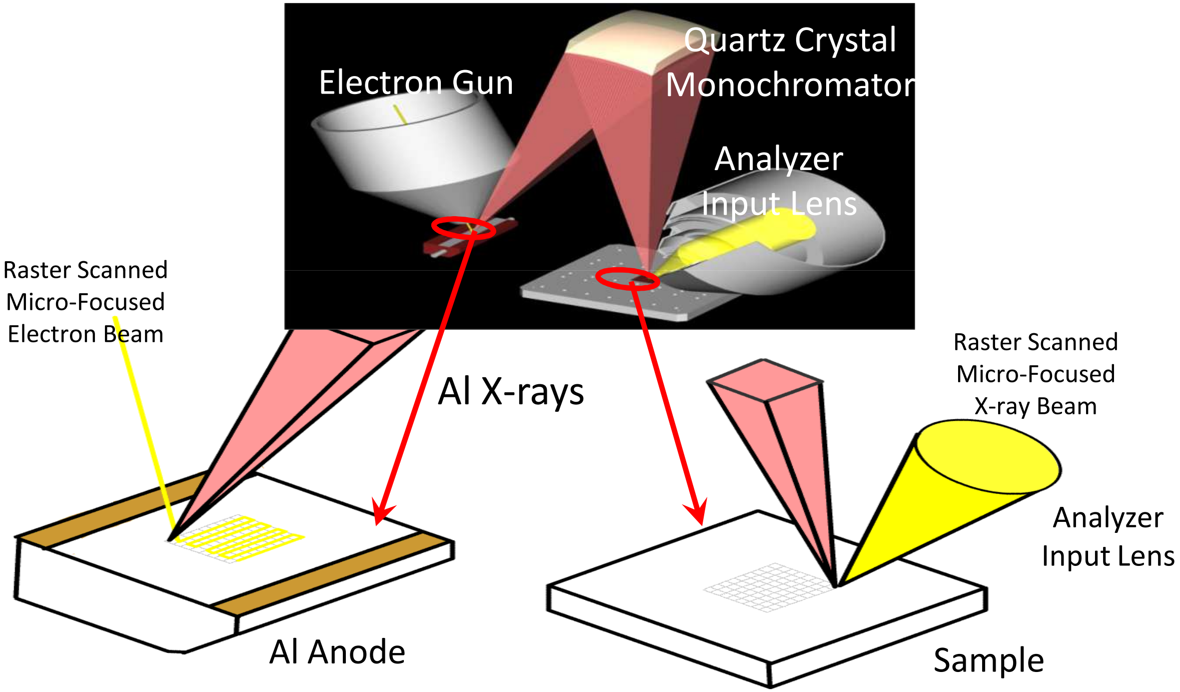
BL 5.2: SUT-NANOTEC-SLRI

PHI 5000 VersaProbe II Scanning XPS Microprobe

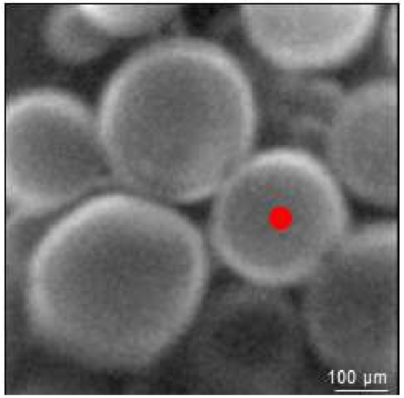


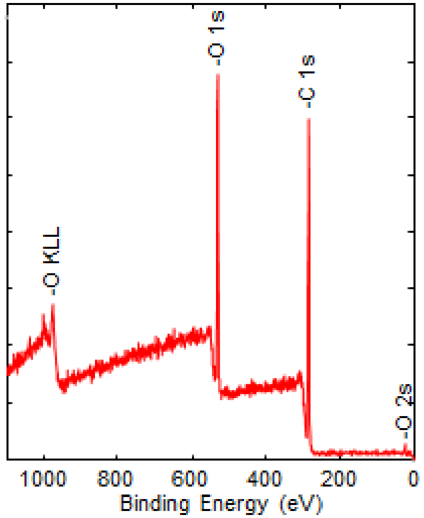
- **Scanning monochromatic X-ray source (Al Kα) with a focused beam ≤10 µm**
- **Argon ion gun for sample cleaning and depth profiling**
- **Dual beam charge compensation system**
- **Sample can be heated up to 800 °C in static mode and 500 °C in dynamic mode.**

Scanning monochromatic X-ray source (Al Kα) with a focused beam ≤10 µm



Secondary Electron Images of PMMA micro spheres

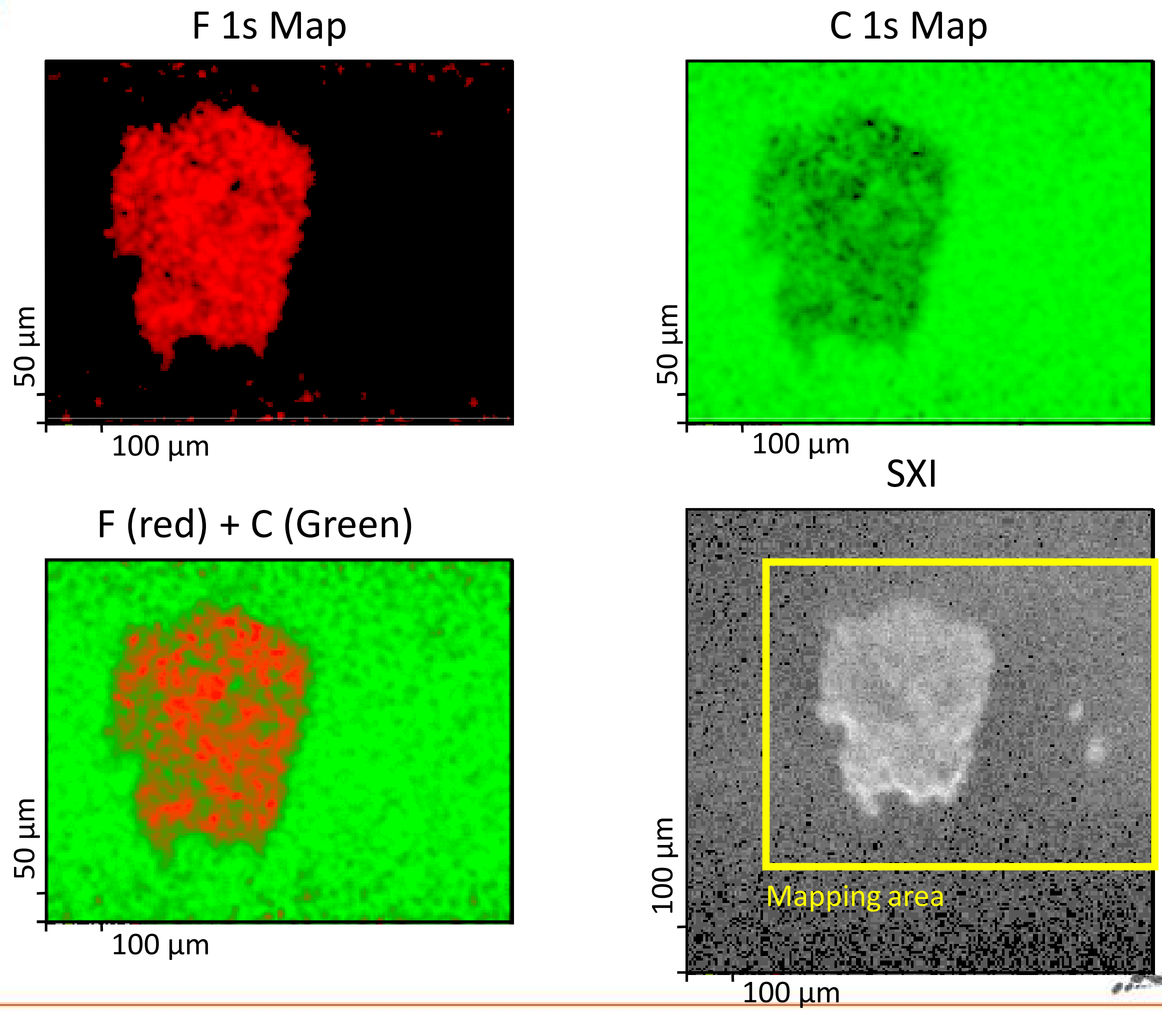




https://www.phi.com/surface-analysis-equipment/versaprobe.html

BL 5.2: SUT-NANOTEC-SLRI

- **XPS maps provided spatial distribution information and identified areas for additional micro-area spectroscopy**

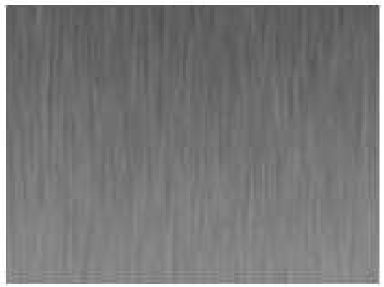


https://www.phi.com/surface-analysis-equipment/versaprobe.html

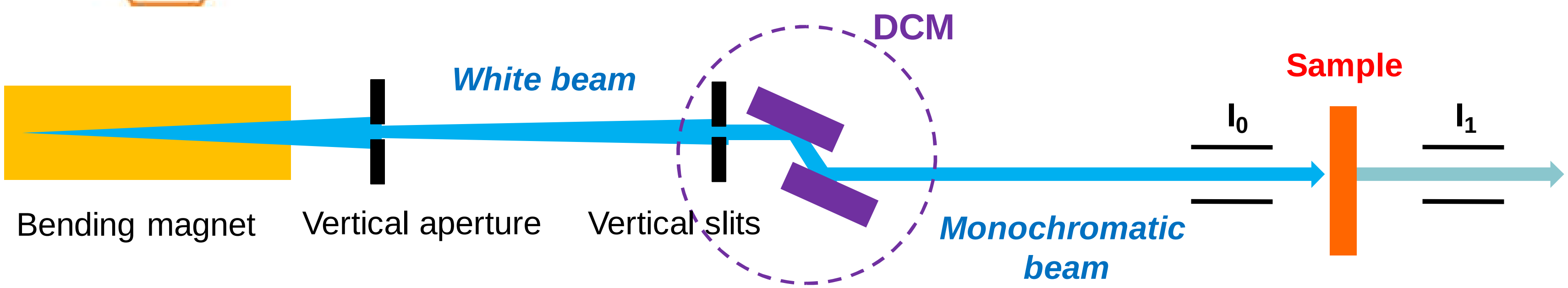
XAS : X-ray Absorption Spectroscopy

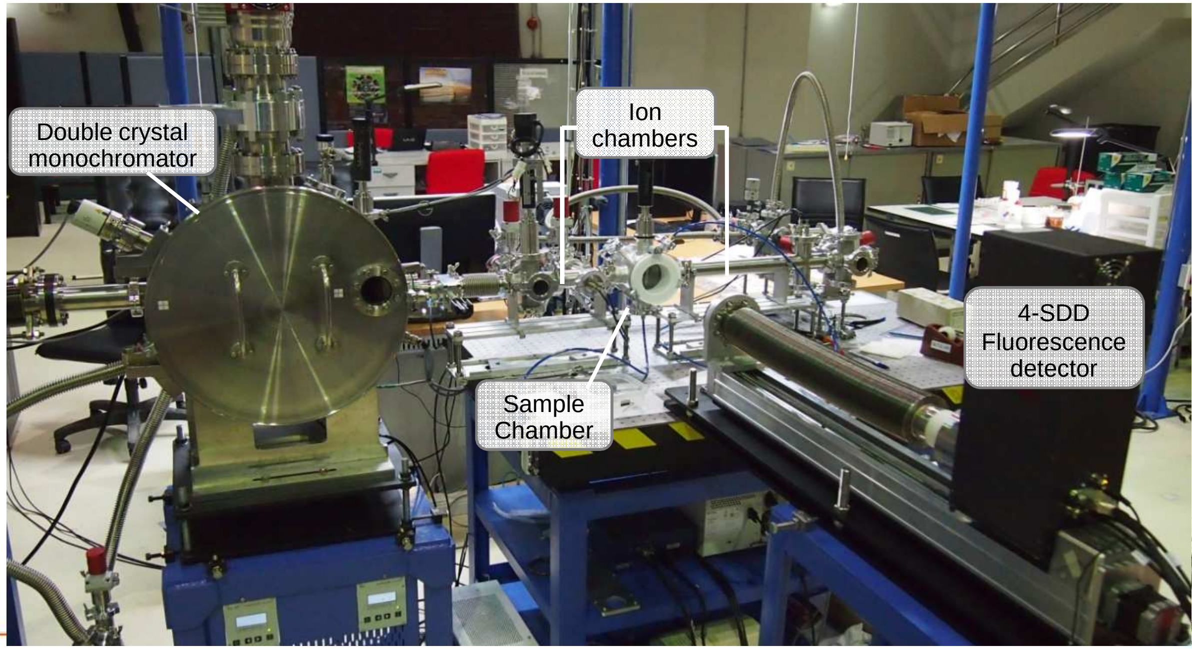
สำหรับศึกษาโครงสร้างระดับอะตอม เช่น การจัดเรียงตัวของอะตอม และการระบุสถานะออกซิเดชั่น (oxidation state) ของอะตอม สามารถประยุกต์ใช้ในงานวิจัยได้หลากหลายสาขา เช่น

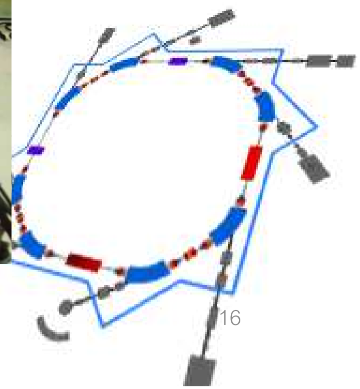
อุตสาหกรรม : ผลิตภัณฑ์เซรามิก เหล็ก ยาง ซีเมนต์และโพลิเมอร์



Conventional XAS beamline : BL 5.2



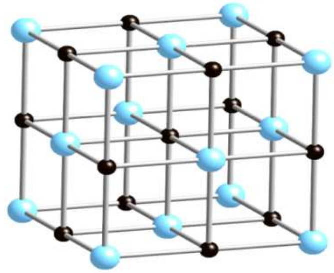


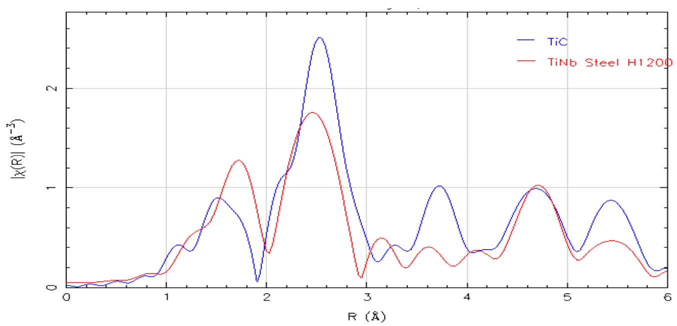


Examples in Metallurgy

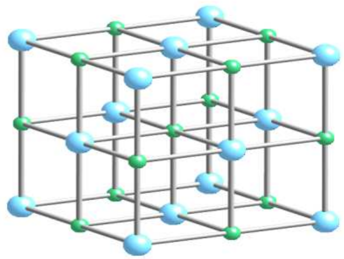
Particle-size estimation of Metal precipitation in high-strength low-alloy steel by XAS

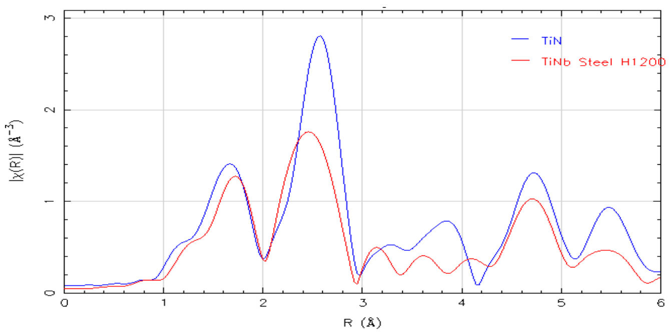
M-C

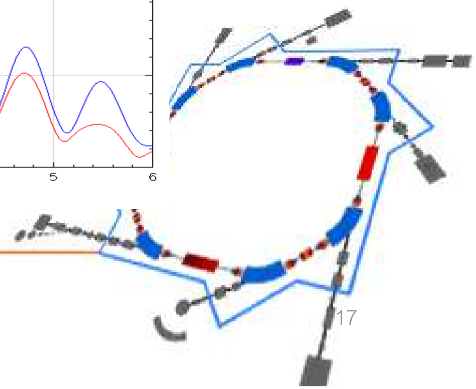




M-N







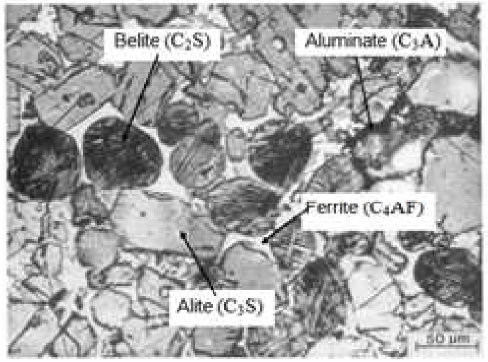
Examples in Metallurgy

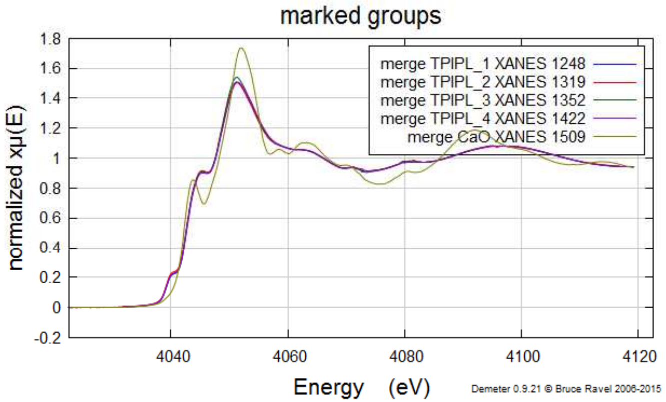
Surface Defect Probed by PES + PEEM +XAS

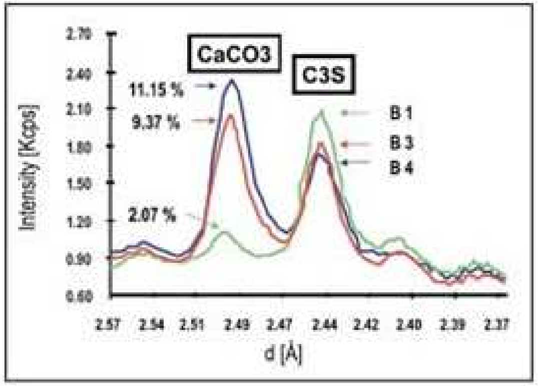


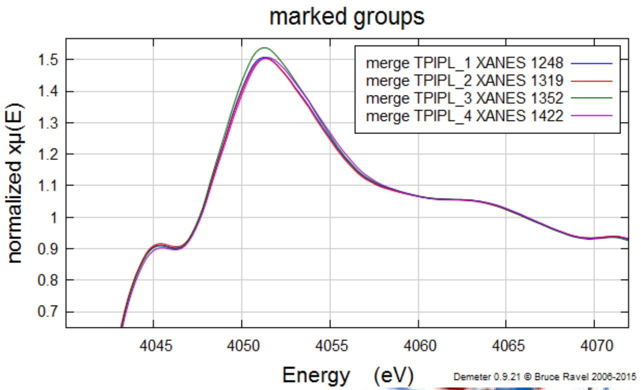
Examples in Cement

Phase Identification of Ca in Cement by XAS









XANES data on Magnetic Materials

Appl. Phys. A
DOI 10.1007/s00339-015-9416-5

Applied Physics A
Materials Science & Processing

CrossMark

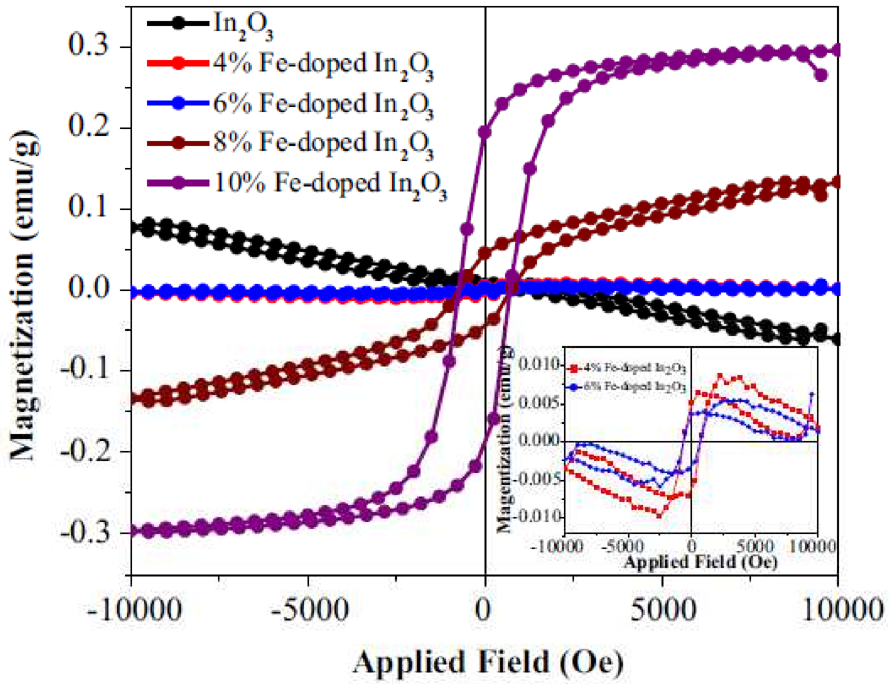
Room-temperature ferromagnetism in Fe-doped In_2O_3 nanoparticles

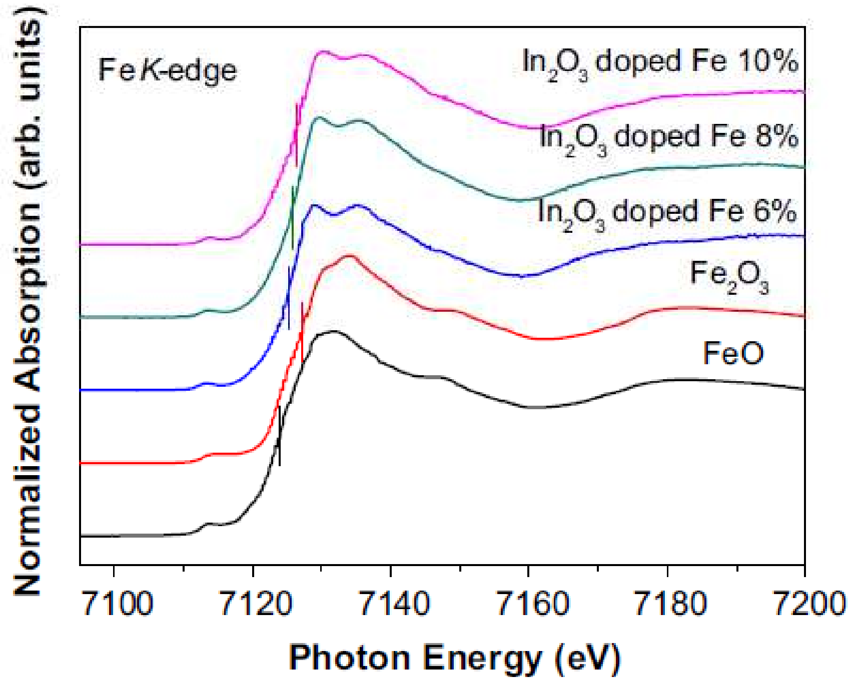
Kwanruthai Wongsaprom[1] · Somchai Sonsupap[1] · Santi Maensiri[2] · Pinit Kidkhunthod[3]

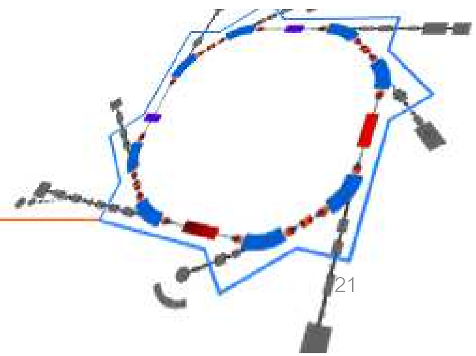
Published online: 08 August 2015

Springer

XANES data on Magnetic Materials







Synchrotron Light Research Institute

XANES data on Magnetic Materials

$$\langle \text{Fe oxidation state} \rangle = 3 \times \frac{\Delta E \text{ of sample}}{\Delta E \text{ of } Fe^{2+} \text{and } Fe^{3+}} + 2 \times \left(1 - \frac{\Delta E \text{ of sample}}{\Delta E \text{ of } Fe^{2+} \text{ and } Fe^{3+}}\right)$$

$$\% \text{ of } Fe^{2+} = \left(1 - \frac{\Delta E \text{ of sample}}{\Delta E \text{ of } Fe^{2+} \text{ and } Fe^{3+}}\right) \times 100\ \%$$

$$\% \text{ of } Fe^{3+} = \left(\frac{\Delta E \text{ of sample}}{\Delta E \text{ of } Fe^{2+} \text{and } Fe^{3+}}\right) \times 100\ \%$$

In_2O_3 sample	ΔE of sample (eV)	⟨Fe oxidation state⟩	% of Fe^{2+}	% of Fe^{3+}
$x = 0.06$	3.35	2.63 (2)	37.27	62.73
$x = 0.08$	4.02	2.75 (1)	24.72	75.28
$x = 0.10$	4.58	2.86 (3)	14.23	85.77

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applications and materials science

Original Paper

Local structure determination of substitutional elements in $Ca_3Co_{4-x}M_xO_9$ (M = Fe, Cr, Ga) using X-ray absorption spectroscopy

Supree Pinitsoontorn[*,1,2], Natkrita Prasoetsopha[3], Pornjuk Srepusharawoot[1,2], Atipong Bootchanont[4], Pinit Kidkhunthod[5], Teerasak Kamwanna[1,2], Vittaya Amornkitbamrung[1,2], Ken Kurosaki[6] and Shinsuke Yamanaka[6]

[1] Department of Physics, Faculty of Science, Khon Kaen University, Khon Kaen, 40002, Thailand
[2] Integrated Nanotechnology Research Center, Khon Kaen University, Khon Kaen 40002, Thailand
[3] Materials Science and Nanotechnology Program, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand
[4] School of Physics, Institute of Science, Suranaree University of Technology, Nakhon Ratchasima , Thailand
[5] Synchrotron Light Research Institute (Public Organization), Nakhon Ratchasima, Thailand
[6] Graduate School of Engineering, Osaka University, Suita 565-0871, Japan

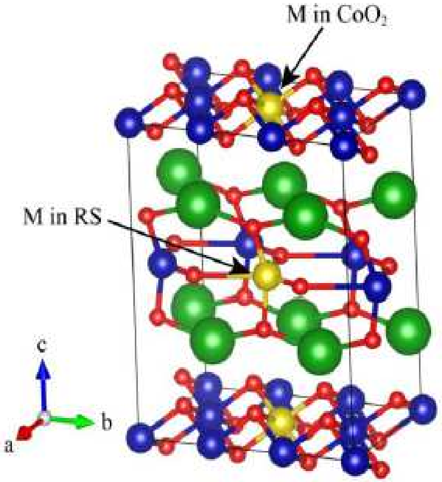
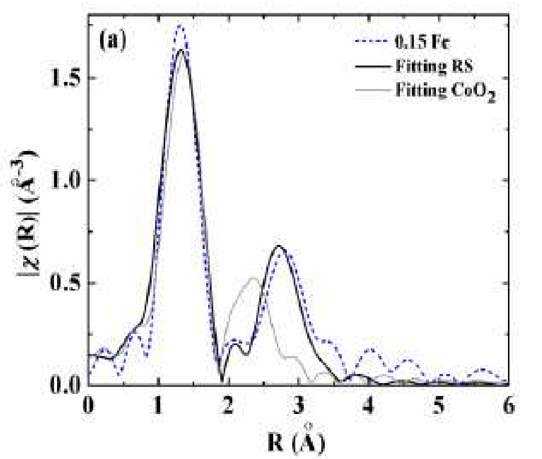
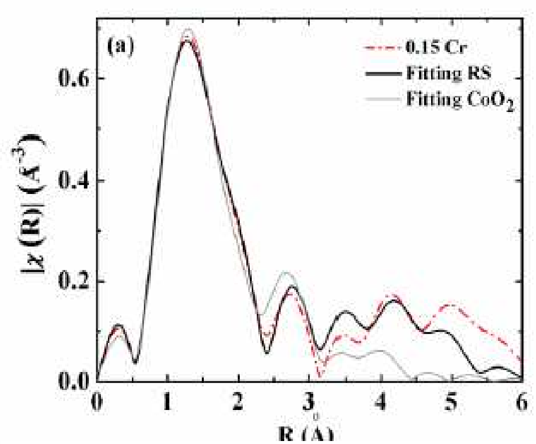
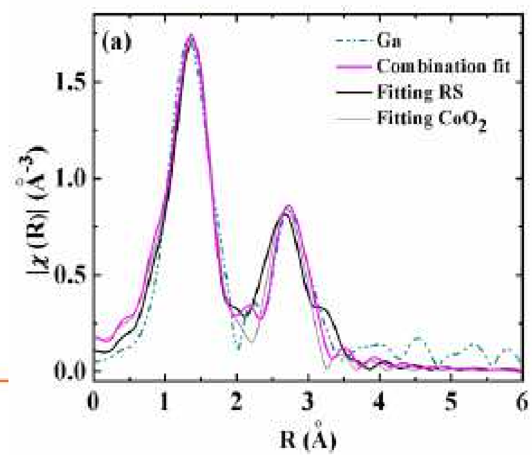
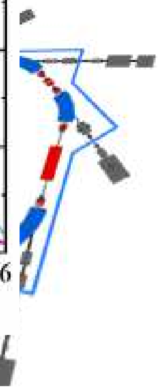


Figure 1 Structure model of $[Ca_2CoO_3]_4[CoO_2]_6$ when M is substituted in the RS layer or in the CoO_2.







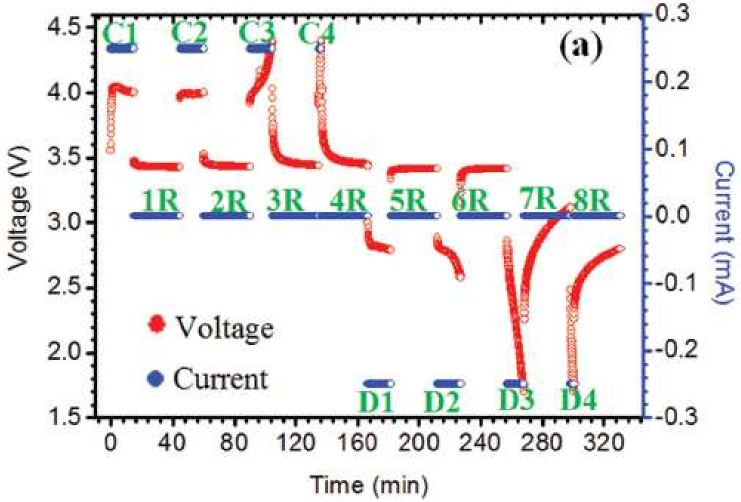


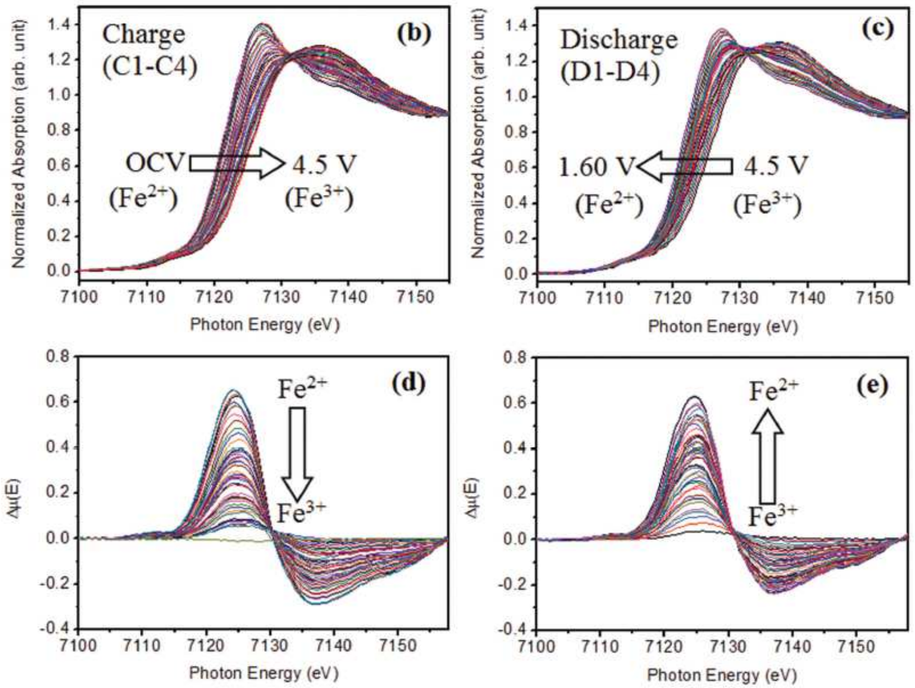
XANES data on Batteries

Materials Views
www.MaterialsViews.com
ADVANCED ENERGY MATERIALS
www.advenergymat.de

XANES Investigation of Dynamic Phase Transition in Olivine Cathode for Li-Ion Batteries

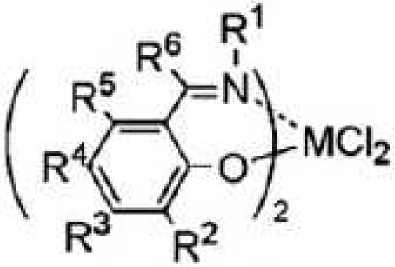
Sarawut Pongha, Boonyarit Seekoaon, Wanwisa Limphirat, Pinit Kidkhunthod, Sutham Srilomsak, Yet-Ming Chiang,* and Nonglak Meethong**





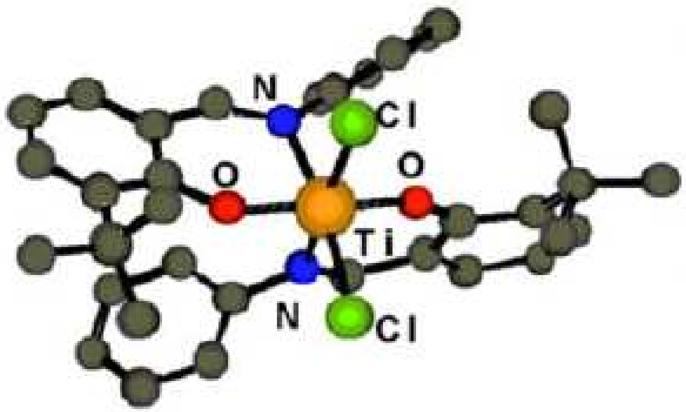
XAS : applications in polymerization

- Describing the ethylene and propylene polymerization behavior of bis(phenoxy–imine) Ti complexes (Ti–FI Catalysts), placing special emphasis on fluorinated Ti–FI Catalysts.



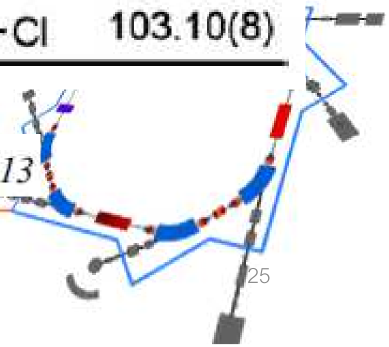
M: Ti, Zr, Hf, etc.

FI Catalysts



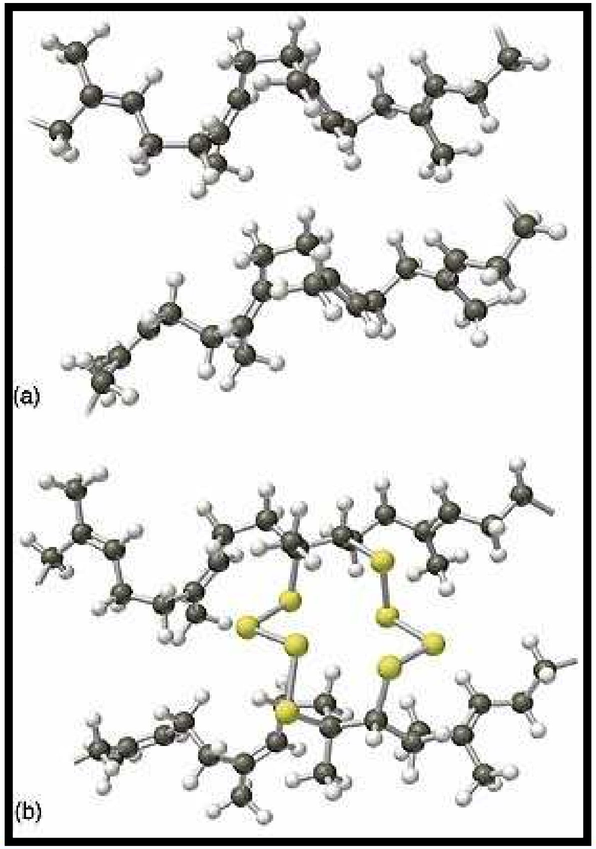
Bond Distances (Å)	
Ti—O	1.852(4)
Ti—N	2.236(4)
Ti—Cl	2.305(2)
Bond Angles (°)	
O—Ti—O	171.6(2)
N—Ti—N	76.4(2)
Cl—Ti—Cl	103.10(8)

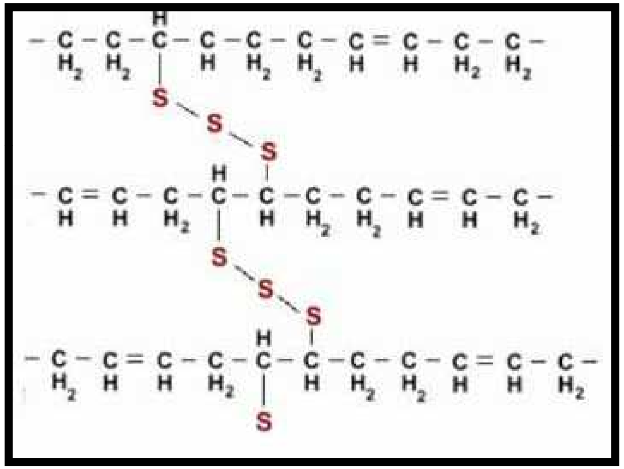
R. Furuyama et al. / Journal of Organometallic Chemistry 690 (2005) 4398–4413

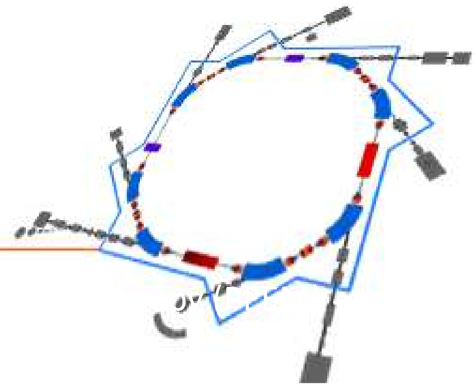


XAS : Cross-link polymers/Rubbers

- Rubbers are harder and more flexible







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XAS for Catalysis Science

Catalysis Science & Technology

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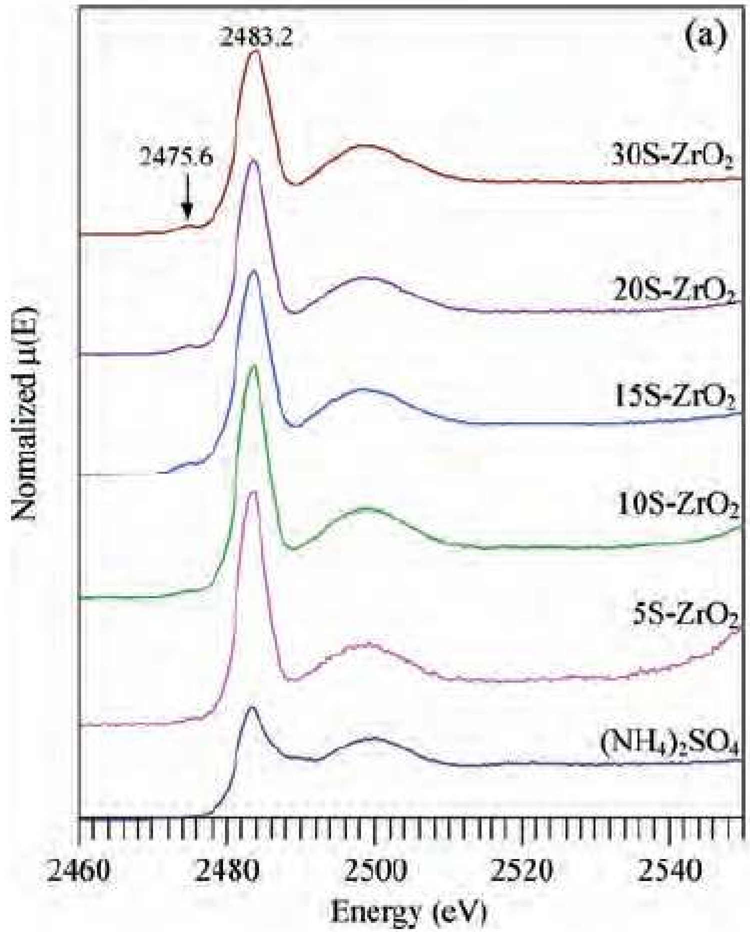
Direct synthesis of dimethyl ether from CO_2 hydrogenation over $Cu–ZnO–ZrO_2/SO_4^{2-}–ZrO_2$ hybrid catalysts: effects of sulfur-to-zirconia ratios†

Thongthai Witoon,*[abcd] Tinnavat Permsirivanich,[a] Nawapon Kanjanasoontorn,[a] Chalairat Akkaraphataworn,[a] Anusorn Seubsai,[a] Kajornsak Faungnawakij,[e] Chompunuch Warakulwit,[bc] Metta Chareonpanich*[abcd] and Jumras Limtrakul[bcd]



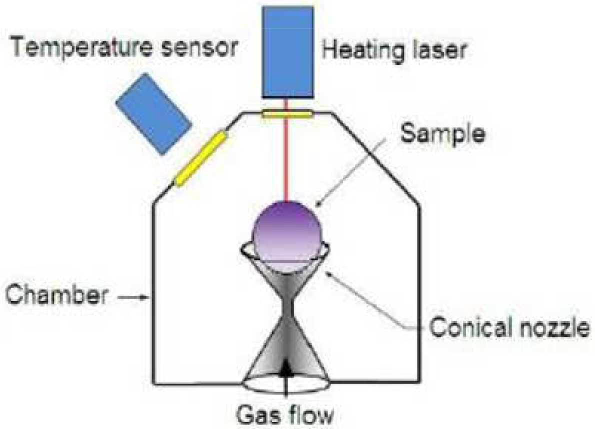
PHYSICAL REVIEW B
condensed matter and materials physics

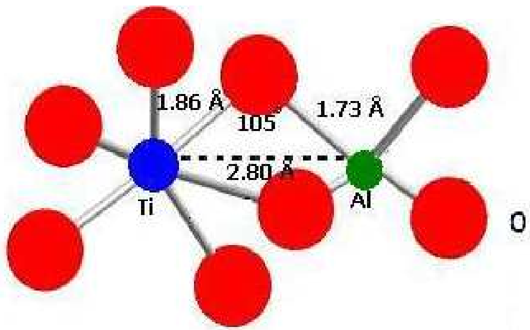
Structure of Ba-Ti-Al-O glasses produced by aerodynamic levitation and laser heating

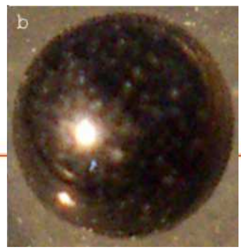
Phys. Rev. B **90**, 094206 – Published 24 September 2014

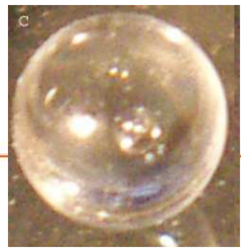
Pinit Kidkhunthod, Lawrie B. Skinner, Adrian C. Barnes, Wantana Klysubun, and Henry E. Fischer

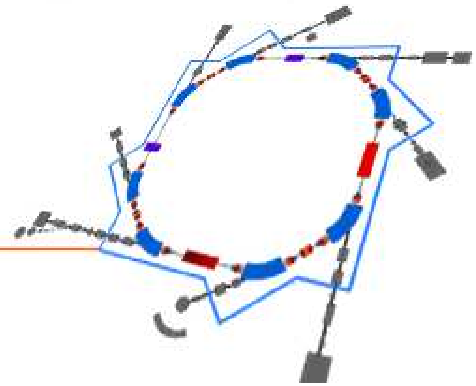
Aerodynamic Levitation and Laser Heating (ALLH)











Thank you for your attention

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