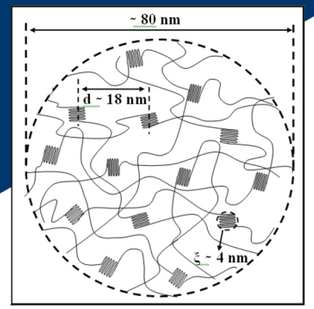
Nano structure of hydrogel. The information about the correlation length (d) and the average distance between crystallites (ξ) of Polyvinyl alcohol (PVA) hydrogels were investigated by SAXS technique. These nano-structural parameters of hydrogels obtained under different processing condition gives a better insight into the structure-properties relation and a clue for optimum processing conditions.



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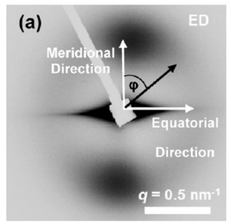
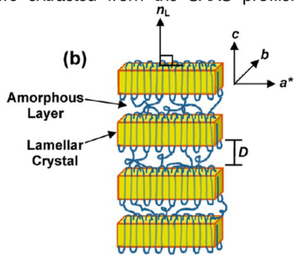
Lamellar structure of polymer. SAXS technique was used to analyze the crystal structure of the nucleating-agent added polypropylene. The SAXS results show the intensity peaked in the meridional direction **(Fig.a)**, indicating the stack of the lamellar crystal arranging perpendicular to the meridional direction **(Fig. b)**. For different types of nucleating agents, several structural parameters such as lamellar repeating period, mean core thickness and mean lamellar thickness were extracted from the SAXS profile.



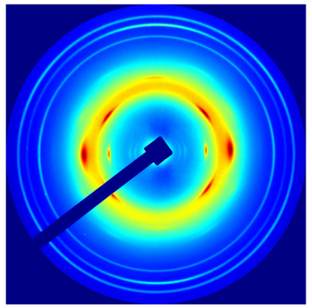
Directions in a SAXS pattern



Schematic model representing cyrstal lamella

Adapted with permission from Rungswang, W.; Thongsak, K.; Prasansuklarb, A.; Plailahan, K.; Saendee, P.; Rugmai, S.; Cheevasrirungruang, W. *Ind. Eng. Chem. Res.* **2014,** *53*, 2331—2339. Copyright 2016 American Chemical Society.

Strain-induced crystallization. Determination of percent crystallinity of silica-reinforced rubber under tension was also studied by *in-situ* WAXS experiment. Under a certain strain, crystalline structure of the stretched rubber was developed as revealed by the red spots in the WAXS pattern. The crystallinity, which is related to the mechanical properties of the rubber, can be calculated from the WAXS profile.



Kavichat Katueangngan and Dr. Nattapong Nithi-uthai,
Prince of Songkla University.

Specifications

Beamline

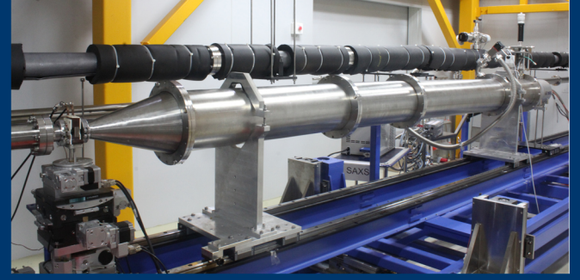
Source: Multipole wiggler

Optics: Double Multilayer Monochromator + Toroidal focusing mirror

Photon Energy: 6-9 keV (optimized at 9 keV)

Photon Flux: 2 x 10^9 photons/sec

Beam size at sample: 1 x 2 mm^2 (V x H)



End Station

Detectors: Rayonix SX165 CCD

Maximum sample-detector distance: 4.5 m

q-range (SAXS): 0.08 – 4.6 nm^{-1}

q-range (WAXS): 2.2 – 40 nm^{-1}

2θ-range: 3.0 – 59 degrees in equivalent to Cu K_α source

Sample type: Solid/Liquid/Gel/Powder/Fiber/Film

Sample volume for liquid: 60 μL

Sample environment: In air/Heating-cooling stage/Tensile stage

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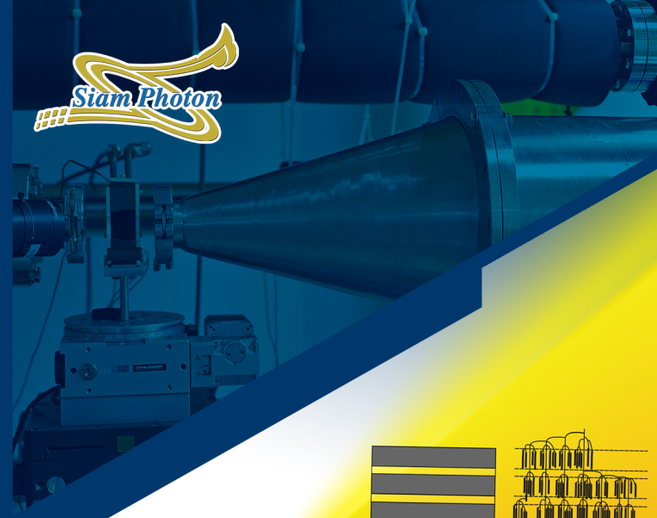
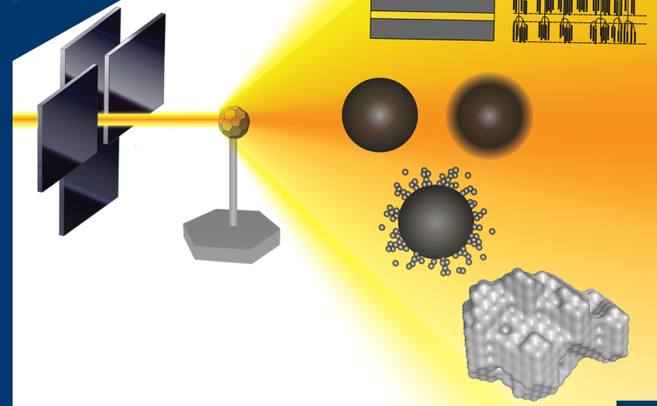




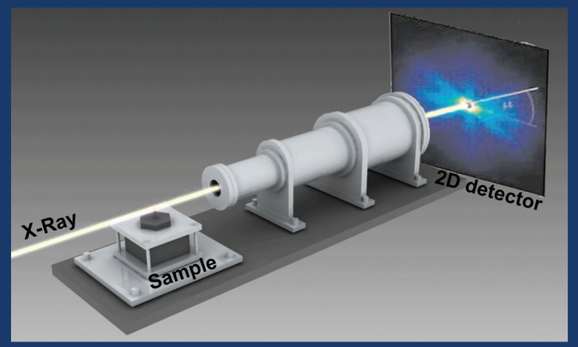
BL1.3W:SAXS/WAXS

Small/Wide Angle X-ray Scattering

Synchrotron Light Research Institute (Public Organization)

What are SAXS and WAXS?

When X-ray is shone onto samples, the photon beam scatters and travels in different directions. The scattering is made by interaction of the photons with electrons inside the samples. The scattering angle is determined by the length scale of the sample which is in the order of nanometer. With a detector system that detects the scattered photon at very small angle, we can record the scattering patterns that can reveal huge amounts of information such as shape, size and size distribution, structural dimension, period of periodic structure, orientation, volume fraction, specific surface area, molecular weight, microfibril angle, etc.. This technique is called 'Small Angle X-ray Scattering' (SAXS). But that's not all, the technique also works well on 'disordered system'-arrangement of atoms in random because SAXS does not need much order to produce useful information. This makes SAXS practical in many fields from material science, polymer, chemistry, food science, to nanotechnology and also perfect for macromolecules or big complex systems. Detecting scattered photon at the larger angle results in 'Wide Angle X-ray Scattering' (WAXS) which is a good complementary technique for SAXS and is often used to determine the crystalline structure of materials.



X-ray scattering experiment

SAXS/WAXS at SLRI

At SLRI, BL1.3W is dedicated to SAXS/WAXS experiments. This beamline utilizes a synchrotron beam from a multipole wiggler of the Siam Photon Source that provides a high intensity x-ray suitable for SAXS/WAXS. The photon flux is optimized by incorporating a double multilayer monochromator (DMM), a focusing toroidal mirror and three sets of collimating slits. Each year, BL1.3W welcomes many researchers who are keen to use the synchrotron light for their SAXS/WAXS experiments.

How it works? Quick and easy to use

1) Sample preparation: Usually non-destructive and sample remains intact. Three types of sample holders are available:

A metal frame (10x10 mm^2 square aperture) for solid, powder, film or fiber samples.

An in-house developed sample cell (sample quantity = 60 μL) using kapton window with heating/cooling stage for liquid and gel type samples. The temperature can be varied between 15 to 200°C.

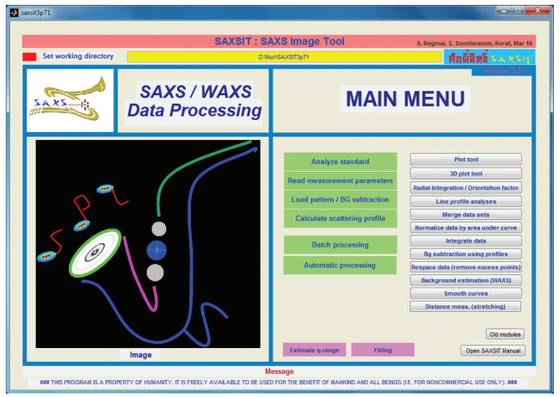
Tensile stage with force up to 500 N for *in-situ* measurements.

2) Data collection time: about 1-5 min depending on scattering intensity from sample

3) Data treatment:

3.1) Data reduction and subtraction by SAXSIT

SAXS/WAXS data reduction from 2D image to 1D scattering profile can be carried out using SAXSIT, a Matlab-based software developed at SLRI. Automatic mode is also available for on-the-fly data reduction. This is useful especially for in-situ measurements in which large amount of data are generated. Some basic SAXS/WAXS data processing and fitting modules are also provided in the SAXSIT.



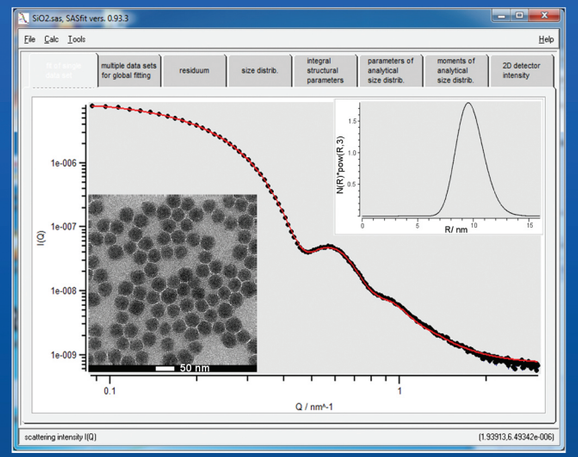
SAXSIT software developed by SLRI

3.2) Further processing by SASFIT or ATSAS

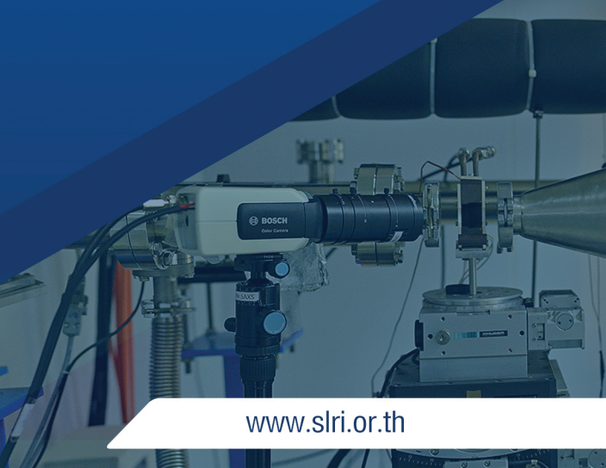
For further processing, users can import the output from SAXSIT, which converts the reduced and subtracted data into spreadsheet and ASCII formats for another data processing program such as SASFIT or ATSAS software packages.

Applications

Size and size distribution of nanoparticle. The figure shows SAXS pattern of silicon dioxide (SiO_2) nanoparticles and its model fitting which was generated by SASfit software. Right inset shows size and size distribution obtained from the fitting. Left inset shows TEM image of SiO_2 nanoparticles.



Dr.Santi Khoonsap and Assoc. Prof. Dr.Sittipong Amnuaypanich, Khon Kean University.



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