



# Small- and wide-angle X-ray scattering (SAXS and WAXS)

## The technology at a glance

Small- and wide-angle X-ray scattering (SAXS and WAXS) use the high brilliance of an undulator source to study condensed matter samples in liquid or solid form. It offers sub-micrometre spatial resolution and deep penetration into materials, such as colloids, polymers, surfactant membranes and proteins, even when these are opaque or turbid. SAXS and WAXS can be combined with other techniques, such as rheology and light scattering, to provide better understanding of sample behaviour on short time scales (sub-milliseconds).

## The added value of the ESRF SAXS/WAXS facilities

The ESRF offers a range of SAXS and WAXS beamlines and combined techniques, thus making it possible to examine different types of specimens with different detail. Also, ESRF beamlines, and in particular ID02, offer higher levels of brightness which means that weaker signals can be treated efficiently. In terms of industrial applications, the ESRF is particularly experienced in studying real product behaviour and has the expertise to set up different sample environments and *in situ* processes that simulate industrial processing conditions. It provides its commercial users not only with raw data, but offers a collaborative work environment geared to producing applicable results.

“ Our techniques allow researchers to see, in very real-life conditions, how products are structured and how they interact. ”

- Narayanan Theyencheri, Scientist in charge of ID02, the main ESRF SAXS and WAXS beamline



using the diffraction technique to examine an experimental early-warning system for detecting breast cancer using hair samples, as a complementary technique to mammography. They have entered Phase III of their research in Australia in what could become a breakthrough technique for women's health worldwide.

**Cosmetic firms** have studied the diffraction of hair to design improved conditioners.

**Pharmaceutical companies** use SAXS and WAXS to study active ingredients and formulas, and their behaviour under different conditions.

**Home product manufacturers** examine, for example,

## Fields of application

**Medical research organisations** use SAXS and WAXS – one example is Fermiscan (Australia) who are currently

detergent efficiency in order to design products that work more efficiently at lower temperatures and use less water.

Several other industrial companies use the facility, from plastics and polymer producers to manufacturers of Kevlar bulletproof jackets.

“What we appreciate the most at the ESRF is that it’s a high-tech, high-profile centre where people practise science at its highest level.”

- Procter & Gamble (UK)

“ID02 is the best beamline we have ever used and potentially the best available for our work. The ESRF staff are easy to deal with, they are friendly, communicative and supportive of what we’re trying to achieve. The ESRF is truly the European centre of excellence. Through working at the ESRF we have also been able to make important contacts who have helped us in our research.”

- Fermiscan (Australia)

## CASE STUDY

### Clinical trials of an innovative screening test for breast cancer using SAXS analysis of hair performed by Fermiscan Pty Ltd (Australia).

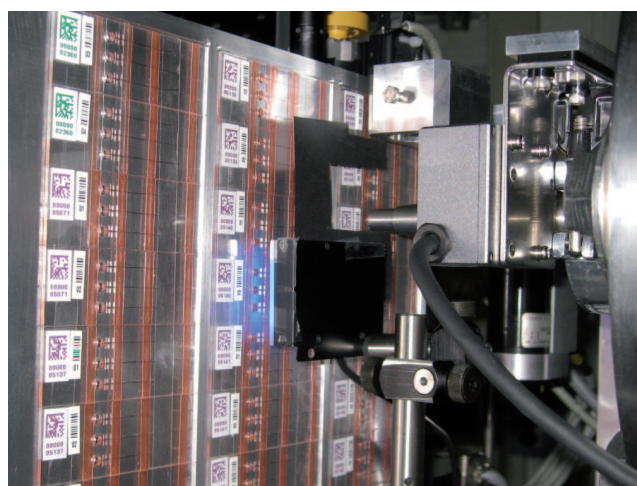
**The challenge:** To confirm the use of SAXS as a determinant for breast cancer.

**Background:** A 2008 study on synchrotron SAXS analysis of hair confirmed an earlier observation that a correlation exists between an altered SAXS pattern of hair and the presence of disease. SAXS patterns of hair from women with breast cancer contain a feature appearing as a ring at  $4.76 \pm 0.07$  nm.

**Results:** Since that time Fermiscan has conducted several trials. In Australia a trial with 2000 patients yielded a sensitivity (i.e. an ability to detect breast cancer) of 74% in women under 70 years of age and a negative predictive value of 99.5%. A recent trial with the National Health Service of Italy yielded a sensitivity of 83% and a specificity (i.e. an ability to accurately detect the absence of cancer) of 76%. Trials have been made in France and Italy.

**How did the synchrotron help?** An automated sample processing system was developed and installed on ESRF beamline ID02 which allowed the analysis of 72 samples without intervention. The high brilliance of

ID02 meant that sample analysis took only a few seconds. Developments of the system with the beamline staff further enhanced the capability of the sample processing system.



The dedicated scanning setup for Fermiscan on ESRF beamline ID02.