Materials

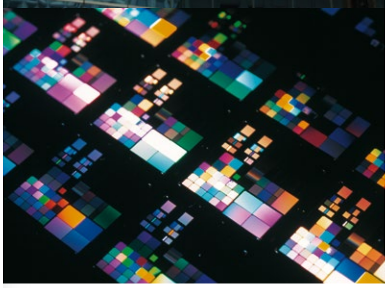
Plastics, glass, steel... materials are used in all major industries. The functional requirements of integrators have led to process adjustments or changes in the composition and constitution of these materials.

The specific properties desired for materials depend on how they are used and the physical, chemical and mechanical properties looked for in the end products from which they are made.

The key issues for the sector relate to composite materials and organic/inorganic hybrid materials, in response to the need for lighter structures and eco-design parameters, nanomaterials and control of the process for nanostructuring matter, in accordance with good health and safety practices, and finally bioplastics made from renewable raw materials (corn, beet, soya...), which help improve the life cycle of products.

The advantages of synchrotron radiation at SOLEIL

- Multi-scale exploration of the molecular organization, chemical composition and micro-morphology of all types of materials.
- Real-time and in situ monitoring of structural modifications induced by different stresses: thermal, mechanical, under flow, in a given chemical environment, in electric or magnetic fields, under irradiation...
- Setting up a microbeam to perform chemical imaging by scanning for spatial localization of chemical elements and functions.
- Access to the local chemical structure around a given atom (type and number of neighboring atoms, interatomic distances), using the specific EXAFS technique.
- Speciation (determination of the oxidation state) of chemical elements by the specific XANES technique in a wide range of spatial resolutions (from mm to µm).



Applications for the sector:

- Measurement of residual stresses.
- Studies on aging and fatigue.
- Monitoring of structural changes as a result of variations in pressure and temperature.
- Studies on thin film coatings.
- The nucleation process and particle growth in crystallized materials.

SOLEIL SYNCHROTRON

Materials contact:
Philippe Deblay: +33 (0)1 69 35 90 05
industrie@synchrotron-soleil.fr

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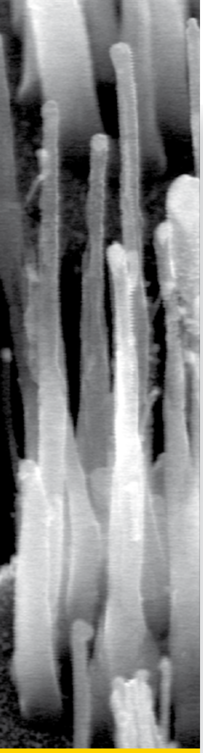
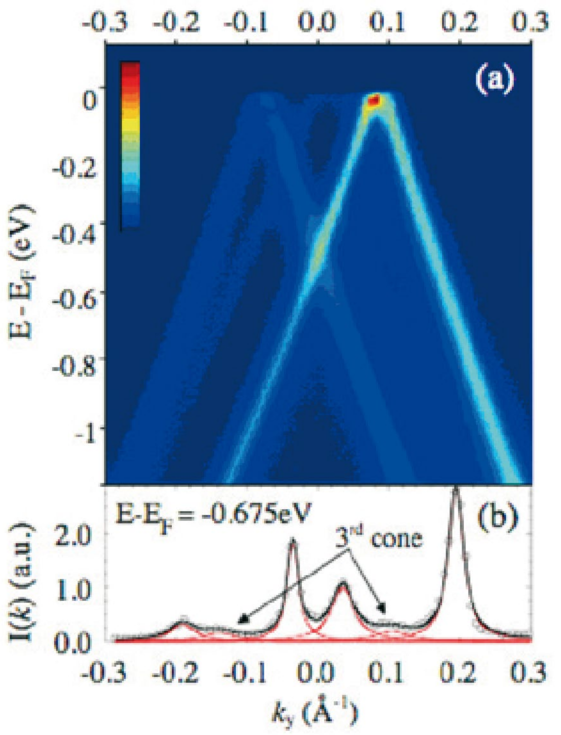


Graphene as a material of the future for high-frequency electronics

A study on the CASSIOPEE beamline showed that multi-layered epitaxial graphene produced from silicon carbide (SiC) is composed of decoupled graphene sheets (without interaction).
Angle-resolved photoemission spectroscopy shows that the energy/electronic band momentum relationship is linear (not quadratic) for multi-layers, as for single graphene layers. This is due to single rotational stacking between adjacent graphene sheets. This result confirms that epitaxial graphene is an ideal platform for electronic components based oncarbon. Graphene is an atomic graphite monoplane.
Its two-dimensional honeycomb atomic structure gives it electronic properties similar to those of light and allows it to achieve extremely high electron mobility. This high mobility, as well as the high electrical and thermal conductivity, chemical stability and the ability to modulate conductance through an electrostatic gate, make graphene a promising material for high frequency electronics, with a switching time in terahertz rather than gigahertz, as at present.



(a) Band structure of 11graphene layers C-face produced from 6H-SiC, as measured by ARPES. The temperature of the sample is 6 K (-267.15 ° C). Two linear Dirac cones are visible.

(b) Data reduction in (a) E-EF = -0:675 eV shows an indistinct third cone. The thick solid line is a fit to the sum of six Lorentzian lines (thin solid lines).

Sylvie Loison, R&D Engineer at SNECMA

Snecma Propulsion Solide (SPS) designs, manufactures and markets solid propergol motors and composite materials for defense, aerospace and industry. In addition to designing and manufacturing solid propergol motors, SPS aims to be a center of technical and industrial excellence in thermostructural composites and to deploy its expertise in the aerospace industry.

SPS has had a first practical approach to the analytical potential of SOLEIL as part of an experiment conducted during the summer of 2010. For SPS engineers, SOLEIL offers new ways of characterizing materials and provides access to information on a smaller scale than that obtained with traditional laboratory equipment.

Conducting additional tests with SOLEIL equipment and personnel should enable SPS to specify the synchrotron techniques of interest to meet its current industrial requirements and for future plans.

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