Synchrotron light for the Aerospace Industry

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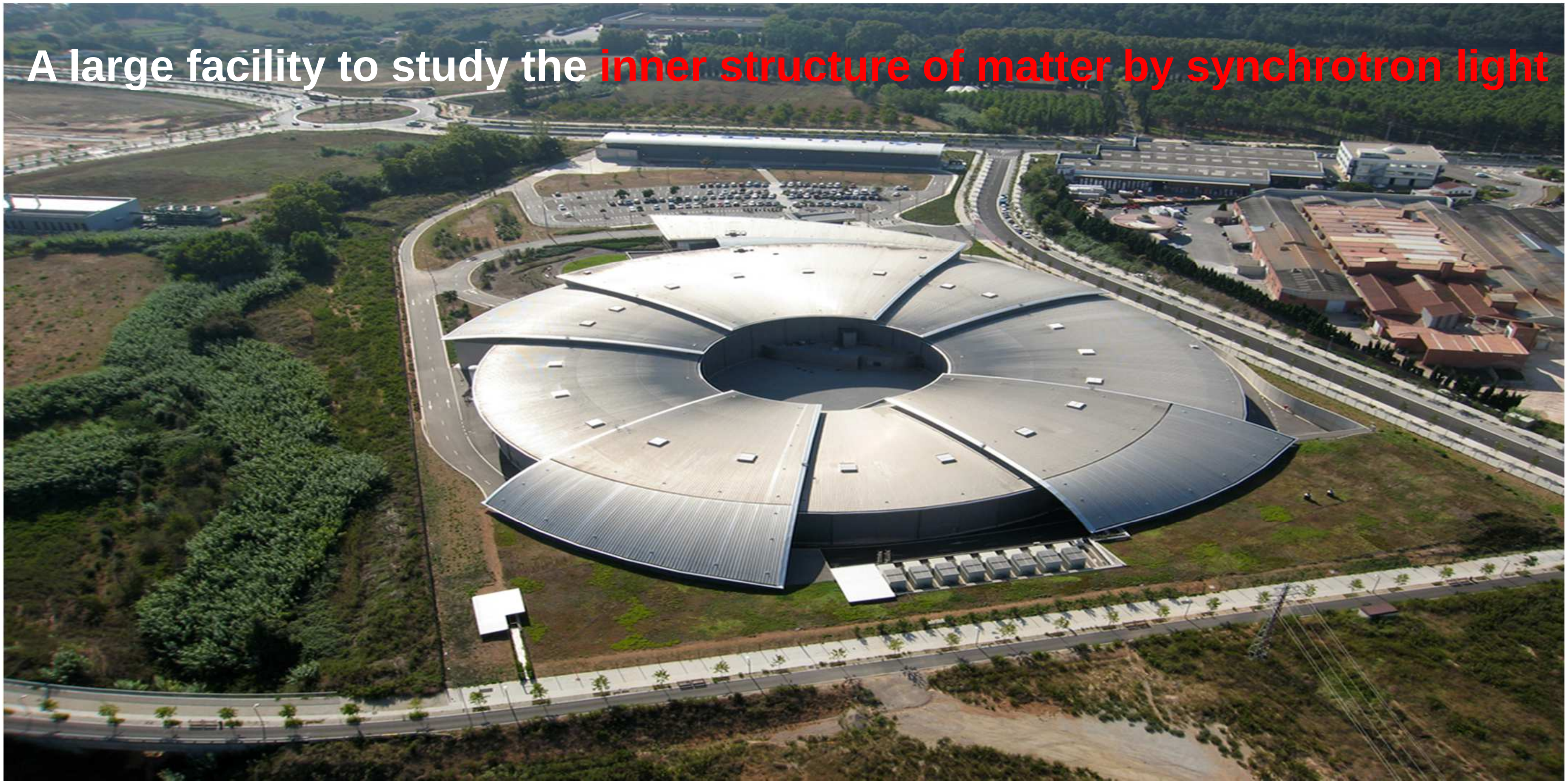
ALBA Synchrotron Light Source

ALBA Synchrotron in short



1st
SCIENCE FACILITY
IN SOUTH-WEST EUROPE

~1300
RESEARCHERS PER YEAR

210 M€
PUBLIC INVESTMENT
(2011)

200
STAFF (20% INTERNATIONAL)

~200
EXPERIMENTS PER YEAR

~5000
HOURS PER LAB PER YEAR

TOP-NOTCH RESEARCH IN:

- BIOTECHNOLOGY AND LIFE SCIENCES
- MICROELECTRONICS AND NANOTECHNOLOGY
- ENVIRONMENT, ENERGY AND AEROSPACE
- MATERIALS DESIGN, DRUGS AND FOOD
- CULTURAL HERITAGE

WHY
DO COMPANIES USE ALBA SYNCHROTRON ?

The ALBA Synchrotron techniques allow to obtain outstanding results not achievable with other equipments or techniques very valuable to help boosting the competitiveness of companies.

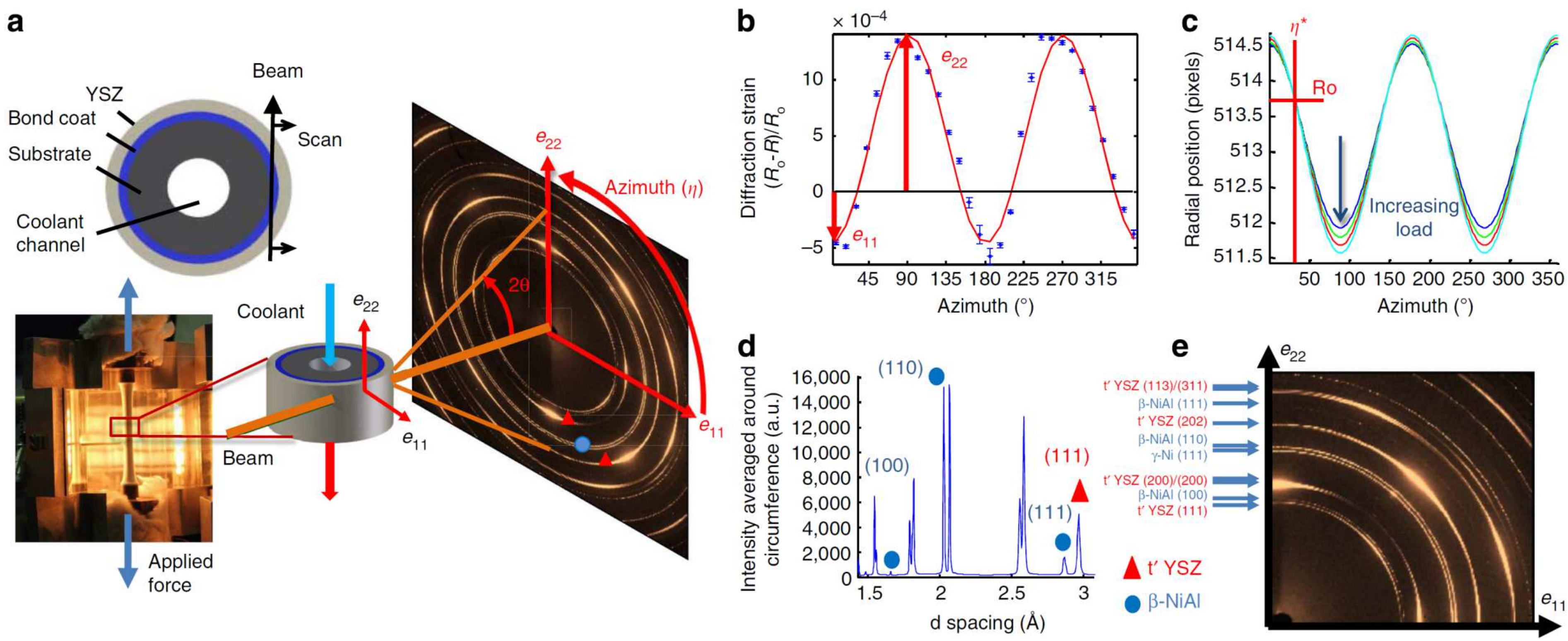
Synchrotron light techniques:

- X-ray microscopy
- Powder diffraction
- X-ray absorption
- IR micro-spectroscopy
- Macromolecular crystallography
- Small and wide angle scattering (SAXS and WAXS)
- X-ray absorption
- Photoemission (microscopy, near ambient pressure)
- X-ray magnetic dichroism

- LOWER DETECTION LEVELS
- CHEMICAL MAPPING
- OXIDATION STATE DETERMINATION
- HIGHER RESOLUTION
- FASTER EXPERIMENTS
- WIDE VARIETY OF SAMPLES MEASURABLE

Strain response of thermal barrier coatings of jet engine turbine blades

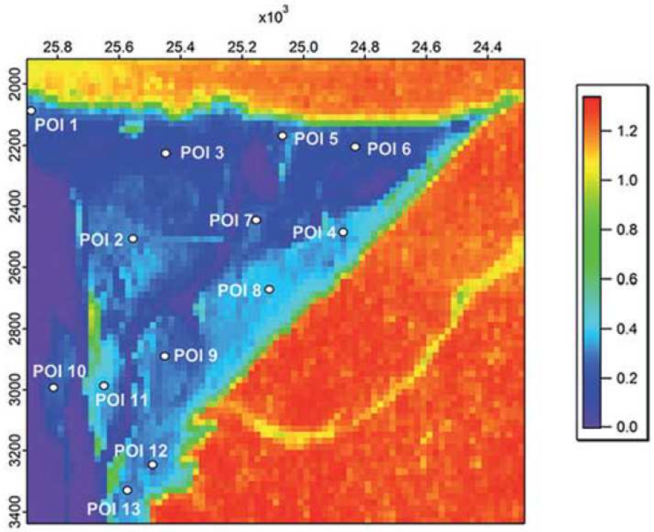
Synchrotron X-ray Diffraction (XRD)

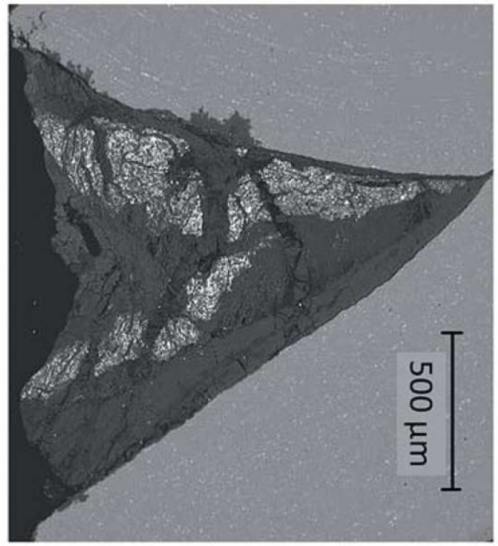


- Depth-resolved strains in-situ measurements under thermal gradients and mechanical loads
- The larger strains are located near the interface with the bond coat
- The results will be used to validate models and close the design loop in creating more durable coatings

Knipe, K. et al. Strain response of thermal barrier coatings captured under extreme engine environments through synchrotron X-ray diffraction. Nat. Commun. 5:4559 doi: 10.1038/ncomms5559 (2014)

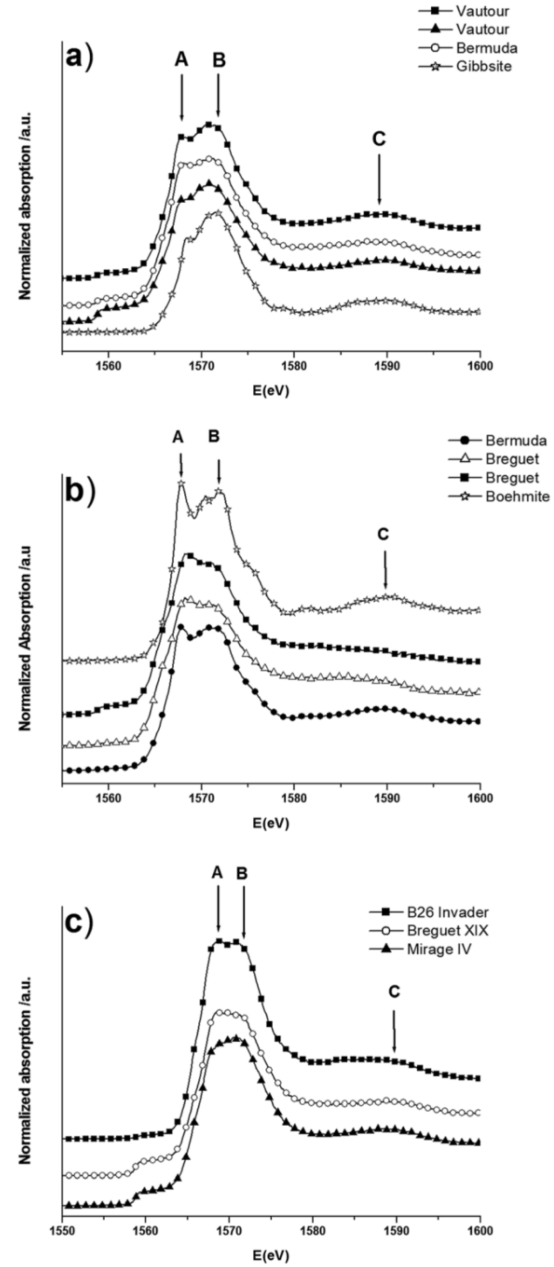
Aluminum corrosion layers of air and space museum aircrafts





XRF (Synchrotron X-ray Fluorescence) map and SEM image recorded on the Bermuda sample with the locations of the XANES acquisitions

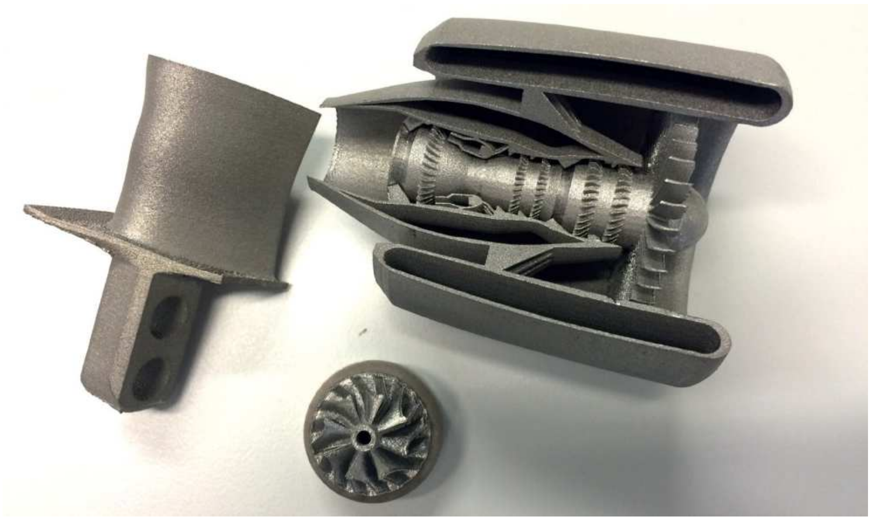
- Corrosion products are mainly composed of poorly crystalized or amorphous phases of 6-fold coordinated Aluminum.
- No 4-fold coordinated Aluminum has been detected



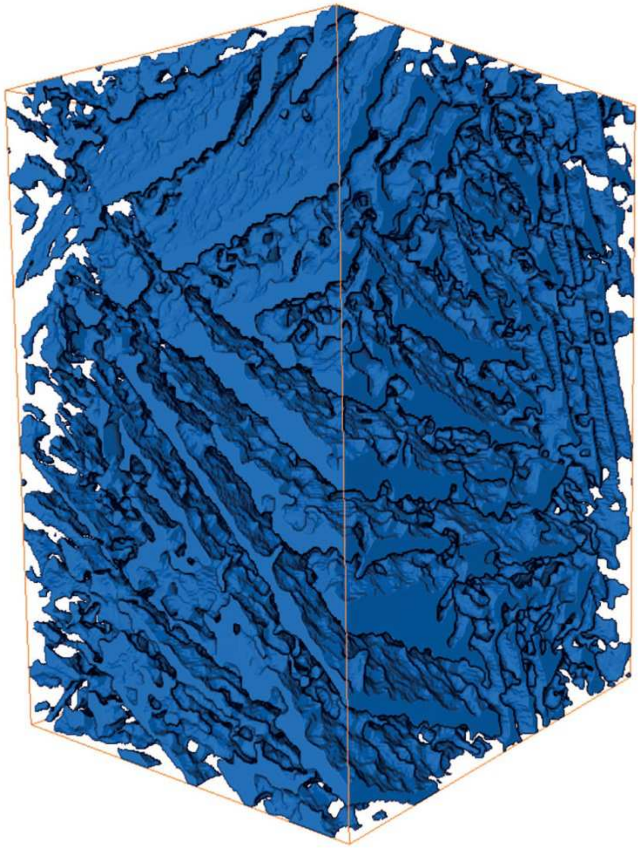
XANES (Synchrotron X-ray absorption) spectra recorded at the Al-K edge

Mirambet, F. et al. J. Anal. At. Spectrom., 31, 1631-1637 (2014)

Synchrotron light is helping to improve 3D printing of aerospace components



Aerospace components manufactured with selective laser melting

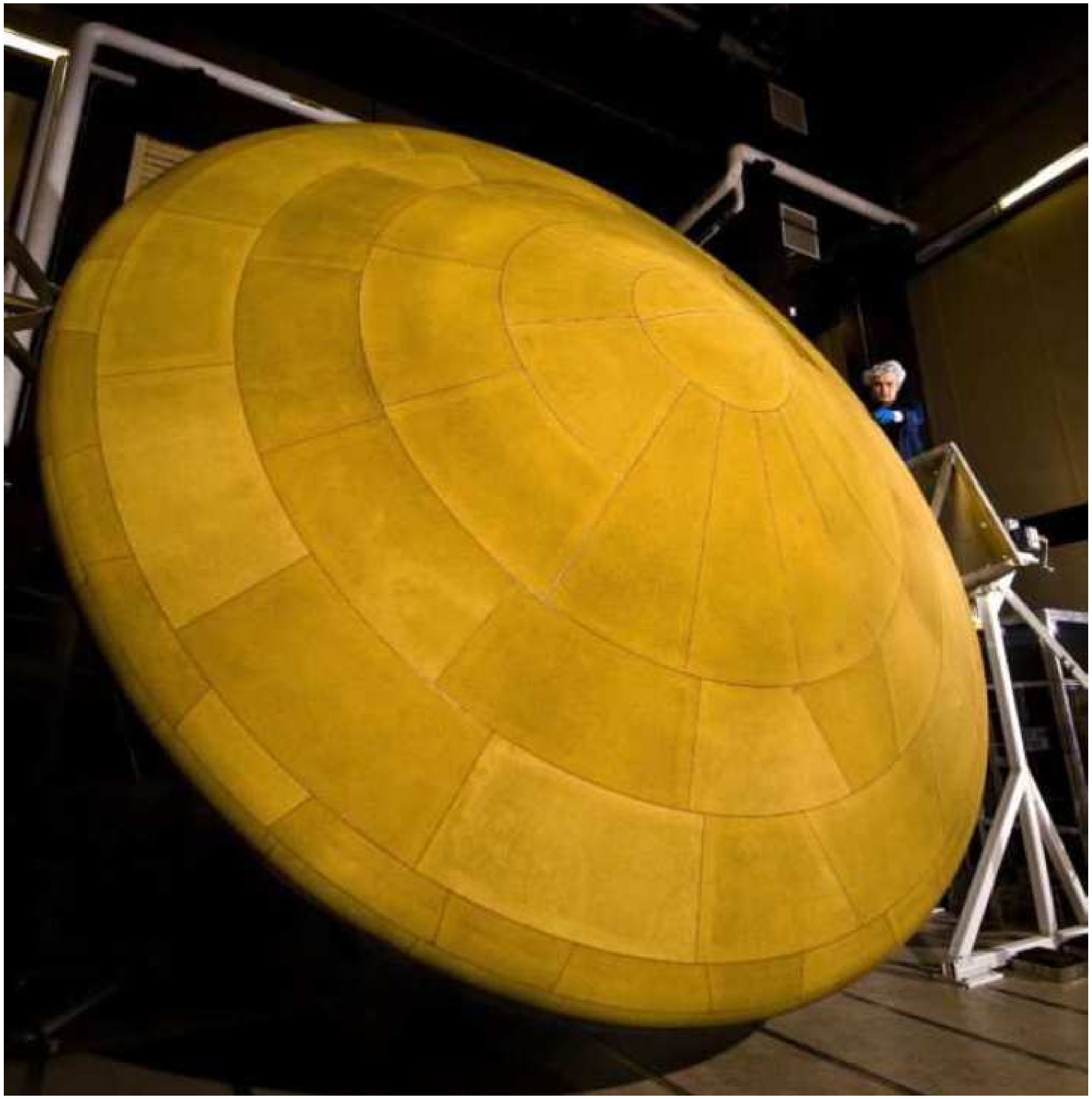


X-ray tomography performed at ID16A of a titanium alloy reveals the connectivity of the hexagonal titanium lattice (blue) with that in a cubic titanium lattice (transparent)

- The degree of connectivity affects the mechanical behaviour of the alloy

Jon Cartwright, ESRF news, March 2017, pag. 29

Synchrotron X-rays reveal how simulated atmospheric entry conditions impact spacecraft shielding

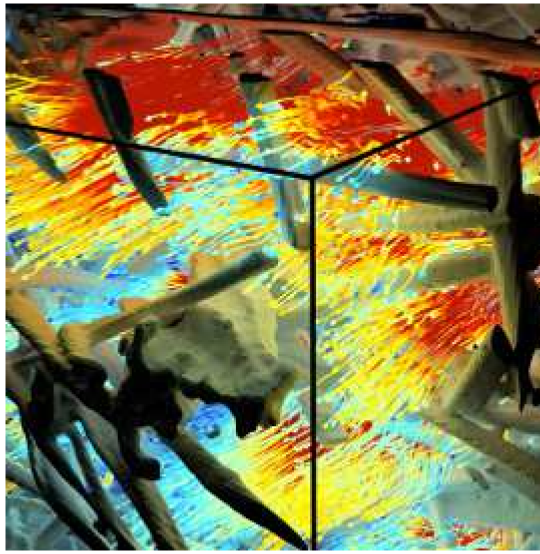


The Mars Science Laboratory (MSL) spacecraft that landed the Curiosity rover on Mars endured the hottest, most turbulent atmospheric entry ever attempted in a mission to the Red Planet. The saucer-shaped MSL was protected by a thin, lightweight carbon fiber-based heat-shield material that was a bit denser than balsa wood

Credit: NASA/JPL-Caltech/Lockheed Martin

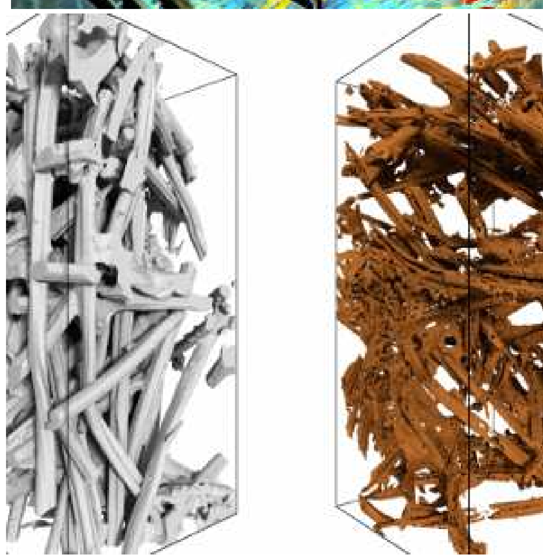
Synchrotron X-ray tomography of woven carbon fiber-based heat-shield material

A simulation of gas flow (represented by arrows) in a porous carbon-fiber insulator material.



A zoom-in rendering of a 1-cubic-millimeter sample of a felt substrate used in flexible heat-shield materials.

Renderings of the untreated (white) and oxidized (bronze) samples of the substrate of NASA's Phenolic Impregnated Carbon Ablator, or PICA, heat-shield material.



A simulation of the decomposition of carbon fibers during high-temperature exposure to oxygen particles.

(Credits: Timothy Sandstrom/NASA Ames; International Journal of Heat and Mass Transfer, Volume 106, March 2017, pages 1318-26, and Volume 108, Part A, May 2017, pages 801-11; and Carbon, Volume 96, January 2016, pages 57-65)

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Synchrotron light can help the Aerospace industry!