

Prof. Yael Politi

Controlling fiber orientation in insect exoskeleton.

Research: The geometrical similarity between helicoidal fiber arrangements in biological extracellular matrices, such as bone, plant cell walls, and arthropod cuticle, and cholesteric liquid-crystalline phases has led to the hypothesis that these structures may arise through self-organization rather than direct cellular control. We investigated this hypothesis during cuticle formation in the tibia of the migratory locust, Locusta migratoria. Using FIB/SEM volume imaging and scanning X-ray scattering, we show that epidermal cells establish the initial fiber orientation, while the final architecture emerges through self-organized co-assembly of chitin and proteins. Thus, cuticle fiber organization results from an interplay between active cellular control and passive self-organization.

Background: Yael Politi is a Professor of "Bioprospecting" at the B CUBE – Center for Molecular Bioengineering at Technische Universität Dresden, Germany, where she has led her research group since 2019. Her academic journey began at the Weizmann Institute of Science in Rehovot, Israel, where she completed her Ph.D. program in the Department of Structural Biology from 2005 to 2009 under the guidance of Prof. Lia Addadi and Prof. Steve Weiner. Following her doctoral studies, she moved to Germany for a postdoctoral position from 2009 to 2012 at the Max-Planck Institute for Colloids and Interfaces in Potsdam, working within the Department of Biomaterials under the mentorship of Prof. Peter Fratzl. Recognizing her expertise in natural materials, the same institution appointed her as a Group Leader from 2012 to 2019, where she headed the "Biological chitin-based tools and sensors" research unit before transitioning to her current professorship.



Dr. Luca Bertinetti

Principles of X-Ray Scattering, 4D XRD, and Multimodal Imaging

Research: Biological materials are hierarchically organised composites whose functional properties emerge from the local arrangement, orientation and composition of their nanoscale building blocks. Capturing this heterogeneity requires methods that combine structural sensitivity with spatial resolution. Scanning X-ray diffraction—also termed 4D-XRD—meets this need: by raster-scanning a focused beam across a sample and recording a full 2D diffraction (SAXS/WAXS) pattern at each point, one obtains a two-dimensional map in which every pixel carries the complete reciprocal-space signature of the local structure. Adding an environmental or temporal dimension (humidity, mechanical load, time, or a chemical stimulus) extends the approach further, enabling in situ observation of structural responses and dynamics.

In this contribution I will introduce the principles and practical implementation of 4D-XRD (with specific focus on synchrotron sources), and the data-analysis pipeline that turns terabyte-scale diffraction datasets into interpretable maps. I will illustrate this versatility through case studies range of biological systems: hydration-driven structural changes and water–matrix coupling in biological tissues, load-dependent and osmotic pressure induced deformation of collagen and mineralised tissues, and the spatial organisation of crystalline and fibrillar phases in natural composites.

Background: Luca Bertinetti is a Senior Scientist at TU Dresden under the Chair of Bioprospecting led by Yael Politi. He earned his PhD in Torino (Italy), studying molecular structure and interactions at the interfaces of biological materials. Between 2010 and 2020 he worked at the MPIKG (Department of Biomaterials), Potsdam, from 2016 leading the group "3D imaging of forming tissues".