Universität Basel

Swiss Nanoscience Institute

SNI SWISS NANOSCIENCE INSTITUTE
EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

Imaging Cardiovascular Macro- and Microstructure Using HfO_2 Nanocrystals as X-ray Tomography Contrast Agents

Principle investigators: Prof. Dr. Jonathan De Roo (Department of Chemistry, University of Basel) and Dr. Anne Bonnin (Paul Scherrer Institute)

In DeRooLab (Department of Chemistry, University of Basel), we are working on the synthesis and analysis of nanocrystals and atomically precise clusters.[1-3] In the X-ray Tomography Group (Swiss Light Source, Paul Scherrer Institut), we are developing instrumentations and algorithms for tomographic X-ray imaging, exploiting synchrotron and laboratory sources.[4-5]

In 2016, cardiovascular diseases were responsible for 31% of all global deaths (WHO). To develop personalized treatment, it is essential to analyse the structural organization of the heart. Synchrotron Radiation X-ray Phase Contrast Imaging (SR X-PCI) is a non-destructive tomography technique, providing 3D information: from full heart morphology down to cellular level microstructure. However, the use of a contrast agent remains necessary to achieve ultra-fast acquisition or improve contrast for cell differentiation.

In the first years, we will learn synthetic inorganic techniques at the University of Basel and develop sustainable syntheses for hafnium oxide nanocrystals and hafnium oxo-clusters. We will then learn how to functionalize the surface to stabilize the particles in biologically relevant media. Finally, we will apply these CT (computed tomography) contrast agents at the Paul Scherrer Institute to visualize the cardiovascular system of the whole heart and improve the contrast in heart transplant biopsies. This experience will offer a broad range of synthetic and analytical techniques, including electron microscopy, nuclear magnetic resonance, X-ray diffraction, X-ray tomography, etc.

[1] J. De Roo et al. *Nat. Mater*. **2016**, *15*, 517

[2] E. Dhaene et al. *Nano Lett.* **2019**, *19*, 7411

[3] Z. Hens and J. De Roo. *JACS*. **2020**, *142*, 15627

[4] M. Stampanoni et al. *Developments in X-Ray Tomography V, Proceedings SPIE.* **2006**, 6318, U199-U212

[5] H. Dejea et al. *Scientific Reports.* **2019,** 9(1): 6996

[6] H. Dejea et al. *FIMH Springer, Cham.* **2017**