Sujet de thèse

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Variable field-of-view x-ray crystalline microscopy for in vivo study of biomineralization

The advent of 4th generation synchrotron source such as the Extremely Brilliant Source of ESRF is opening exciting perspectives for the study of time-resolved phenomena occurring in physics, chemistry and biology [1]. In this new context, time-resolved crystalline microscopy studies become possible. However, these developments are facing strong challenges resulting from the huge beam intensity, which induces pre-aging of the sample, a common difficulty shared by many other synchrotron-based approaches.

The COMIX team of Institut Fresnel has a long lasting expertise in the development of microscopy approaches based of the resolution of the inverse problem, both for x-rays and visible lights [2,3]. These novel approaches are exploited for the understanding of the biomineralisation process, which describes how living organisms are building their hard-tissues [2, 3].

In this PhD project, we aim at developing ultra-fast crystalline microscopy approaches for the in vivo study of biomineralisation, a new research strategy which becomes possible thanks to the new x-ray sources. The proposed microscopy approach, fully original, is based on the design and structuration of the x-ray beam illumination, which not only reduces locally the dose, but also provides a mean to perform much faster acquisition and opens new perspectives for the design of a variable field-of-view microscopy. The PhD project is structured along three main tasks, presenting increasing risks and gains : the design of the method (probe and inverse problem algorithm) allowing for fast acquisition; the design and demonstration of the variable field of view set-up, in the line of the previous task; The application of the new method to in vivo biomineralisation study, for which preliminary expertise exists at Fresnel [4].

For this PhD project, we look for a highly motivated candidate, with a strong background in experimental optics and/or physics and/or signal analysis and capability in computing approaches. We are expecting a curious and rigorous candidate, willing to learn in an interdisciplinary environment.

[1] https://www.esrf.fr
[2] J. Duboisset et al., Amorphous-to-crystal transition in the layer-by-layer growth of bivalve shell prisms, Acta Biomaterialia, **142,** 194 (2022).
[3] F. Mastropietro et al. Revealing crystalline domains in a mollusc shell single-crystalline prism, Nature Materials (2017).
[4] T. Grünewald et al., The crystal formation in calcareous marine biominerals involves multiple crystallization steps - An in vivo study, *under revision.*