The Pan African Conference on Crystallography (PCCR2)
and
The African Light Source Conference (AfLS2)

Contribution ID: **73** Type: **Oral Presentations**

Studying ultrafast out-of-equilibrium transformation with time-resolved techniques at synchrotron and X-FEL

Thursday, 31 January 2019 09:00 (1 hour)

Ultrafast photoswitching in bistable crystals is associated with a complex transformation pathway, multiscale in nature, where both molecular electronic and structural reorganization and macroscopic transformation of the crystal have to be considered [1]. Time-resolved X-ray techniques developing at synchrotron and X-FEL allow for tracking such microscopic transformation on timescales spanning from femtosecond to millisecond and mapping photoinduced structural dynamics [2]. We have studied the basic mechanisms allowing light to switch the magnetic molecular state, from low to high spin through the activation and damping of molecular breathing [3]. In the active medium, which the crystal is, other effects of elastic (propagating) or thermal (diffusive) nature should be considered [1,4,5]. In the case of cooperative solids, a self-amplified and coherent response to light excitation is observed on short time-scales. This self-amplification process resulting from the elastic field induced by light and coupled to the molecular volume change applies to various types of materials and time-resolved X-ray techniques play a key role to understand them.

1. R. Bertoni et al, Nat. Mater., 2016, 15, 606–610.
2. M. Chergui and E. Collet, Chemical Reviews, 117 (16), 11025–11065 (2017)
3. H. Lemke et al, Nature Comm. 2017, 8, 15342
4. R. Bertoni et al, Cryst. Eng. Comm. 18, 7269 - 7275 (2016)
5. C. Mariette et al, Acta Cryst. B73, 660-668 (2017)

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Session Classification: Joint PCCr2 + AfLS2 Plenary

Track Classification: Common : PCCr2 and AfLS2