Disclosing weak phenomena at multiple scales in soft matter using simultaneous SAXS/WAXS laboratory system

Sandra Desvergne-Bléneau[1*], Pierre Panine[1], Manuel Fernandez-Martinez[1], Sergio Rodrigues[1], B. Lantz[1], R. Mahé[1]

[1]*Xenocs, 19 rue François Blumet, 38360 Sassenage, France*

Sandra.Desvergne-Bleneau@xenocs.com

The physico-chemical behavior of soft materials is often complex since it relates the relationship not only between the chemical species in presence [1] but also couples with the environmental conditions as such as but not limited to temperature, stress, … Most of these external fields being essentially subtended by intensive variables, it is particularly adapted to study in the bulk of materials the slow variations of the structure over 2 or 3 decades in space, i.e. from atomic scale up to the mesoscale.

For instance, first order transitions are known for sharp changes in conformation, inducing strong variations on the signal of the detecting instruments, with time constant being relatively small. In liquid-solid transition, the latent heat associated with thermal first order transitions should lead to broad times of observation: "water does not turn into vapor" in a short time. But locally, the transition is almost instantaneous. And the fact is that most x-ray analytical methods are usually probing small volumes, for which the transition will undergo in a short time.

In case of already solid or semi-solid systems, the mass exchange is severely slowed down, leading to much extended transition times. Then in comparison, second order transition being also called "continuous transition" can exhibit a wide variety of paths that are sometimes very much kinetic dependent. In this broad panorama, the recent discovery of order-order transitions as such as quasicrystals in polymers [2] or more lately the Frank-Kasper phases in tetrablock copolymer systems [3] is highlighting the wide variety of time constants in phase transition, from ms up to several days.

As a matter of fact, if fast transitions require intense flux of third generation synchrotrons [4], slow phenomena are ubiquitous and can be studied fruitfully in laboratory systems, offering in one hand less instantaneous flux but with unrivalled availability of beam time. This provides strong support in disclosing slow evolutions of nanostructures and at the same time avoids any severe beam damage. Among others, this paper will be illustrated by the SAXS/WAXS kinetic study of washing powder exposed to moisture. It will be shown that presence of moisture increases mobility at surface of grains, leading to local mass exchange and final formation of cakes, having practical consequences both for washing application and for the environment.

[1] A.V. Zvelindovsky Editor, *Nanostructured soft matter: experiment, theory, simulation and perspectives*, 2007, Springer

[2] K. Hayashida, T. Dotera, A. Takano and Y. Matsushita, *Phys Rev Lett,* 2007, **98,** 195502

[3] S. Lee, C. Leighton and F. S. Bates, *PNAS*, 2014, **111**, 17723

[4] T. Narayanan, R. Borsali and R. Pecora Editors, *Synchrotron small angle x-ray scattering in Soft Matter Characterization*, 2008, **2**, Springer Reference