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Experimental proposal using neutron scattering for structural study of hydrated silks

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Natural protein fibers, silks, are expected as sustainable structural materials because of their excellent mechanical properties, especially the high-toughness nature with a good balance of strength and extensibility. However, the structural origin of the high-toughness of silks has not been well understood. So far, we have studied the hierarchical structure of many kinds of silks on the basis of small-angle and wide-angle X-ray scatterings (SWAXS) and revealed their hierarchical fibrillar structures. Each nanofibril has a periodic repeating structure of crystalline and amorphous phases associated with the specific amino acid sequence. In-situ synchrotron SWAXS measurements during the fiber stretching deformation revealed an essential role of amorphous phase in generating high-toughness nature (Yoshioka T. et al., Nat. Commun. 2019, 10, 1469). On the other hand, silks are known to show high moisture absorption (or hydration) and thus the study on structural deformation process under hydrated state is also very important. However, the SAXS study of hydrated silks gives only poor information because of poor electron density contrast between crystalline and hydrated amorphous phases especially in the stretched state. Here, we want to propose and discuss some experimental designs using neutron scattering for clarifying the structural deformation process of silks under hydrated state as well as some other uncleared structural subjects of silks.

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