Multiscale phenomena in molecular matter

Contribution ID: **89** Type: **not specified**

In situ investigation of the mechanical properties of silk and optically switchable silk with neutron and X-ray scattering

Wednesday, 8 July 2015 10:10 (30 minutes)

The biological structural material silkworm silk combines high extensibility with high mechanical strength. The key to silk's unique mechanical properties lies in the microstructure of this protein fibre with nanocrystals embedded in a softer, disordered matrix. On the basis of results of novel in situ experiments using the techniques of mechanical relaxation [1], neutron spectroscopy [1], small-angle neutron scattering [2] and X-ray microdiffraction [3] we were able to develop new models explaining the contributions of both the amorphous matrix and the nanocrystals to the mechanical properties of silk. In particular, the models hold across many orders of magnitude on time and length scales [1].
Based on this deeper understanding of the composite material, native silk fibres were functionalised with chromophores so that their mechanical properties can be reversibly switched with UV and visible light, respectively [4]. The fibre geometry ensures that unpolarised light is converted into directed mechanical stress. The effect may in the future be used for the development of optically driven micro actuators or the conversion of light into mechanical energy.

References

[1] I. Krasnov,T. Seydel, M. Müller, <i>Phys. Rev. E</i> 91, 042716 (2015).
[2] M. Müller, I. Krasnov, M. Ogurreck, M. Blankenburg, T. Pazera, T. Seydel, <i>Adv. Eng. Mat.</i> 9, 767-772 (2011).
[3] C. Krywka, I. Krasnov, R. Figuli, M. Burghammer, M. Müller, <i>Macromolecules</i> 47, 7187–7193 (2014).
[4] I. Krasnov, N. R. Krekiehn, C. Krywka, U. Jung, A. U. Zillohu, T. Strunskus, M. Elbahri, O. M. Magnussen, M. Müller, <i>Appl. Phys. Lett.</i> 106, 093702 (2015).

Primary author: Prof. MÜLLER, Martin (Helmholtz-Zentrum Geesthacht)

Co-authors: Dr KRYWKA, Christina (Helmholtz-Zentrum Geesthacht); Dr KRASNOV, Igor (Helmholtz-Zentrum Geesthacht); Dr GREVING, Imke (Helmholtz-Zentrum Geesthacht); Mr BLANKENBURG, Malte (Helmholtz-Zentrum Geesthacht); Dr SEYDEL, Tilo (Institut Laue-Langevin Grenoble)

Presenter: Prof. MÜLLER, Martin (Helmholtz-Zentrum Geesthacht)

Session Classification: Multifunctional materials