Project description

**Title**: Molecular mechanics of self-healing hydrogel materials  
**PI**: Kerstin Blank (MPIKG)  
**In collaboration with**: Angelo Valleriani (MPIKG)  

**Project description**: Hydrogels are crosslinked polymeric materials containing large amounts of water. Applications, such as sealing materials, food additives, drug delivery systems and cell culture matrices for regenerative medicine, require hydrogels with well-defined mechanical properties. Rheology is the standard method for determining these properties. For the development of next-generation smart materials, however, rheology must be complemented with techniques that provide insight into the molecular processes occurring upon material deformation and failure.

![Figure 1. Linking molecular and bulk material properties](image)

In this project, we consider hydrogels made of star-shaped polymers connected with reversible crosslinks (Fig. 1). This well-defined structure allows for establishing a direct connection between the mechanical properties of the network and its individual crosslinked chains by combining rheology (network) and single-molecule force spectroscopy (individual crosslinked chains). To study crosslink rupture and self-healing processes you will use crosslinks with different properties. You will carry out all the experiments and learn advanced data analysis methods and modelling to link and correlate the molecular parameters with the hydrogel properties. We also aim to equip the crosslinks with a fluorescence reporter system to directly observe crosslink rupture and self-healing during and after mechanical deformation. This will serve as a direct validation for the models developed and, at the same time, provide a unique new material that self-reports on its mechanical state.

**Required background**: You should have a background in Physics or Physical Chemistry. The project involves experiment, theory and a bit of computer simulations for data analysis. You should be interested in generating data and in working with your data to develop a physical understanding of your hydrogel.


**Contact**: Kerstin Blank (kerstin.blank@mpikg.mpg.de)