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### **Biomimetics Nanocomposites from genetically engineered proteins and biological polymers**

Nature shows several examples of materials that have excellent performance or special functionalities. Composite materials form one example and are interesting because of their mechanical properties. Due to their structure they show an impressive combination of stiffness and toughness that is a challenge to reproduce in man-made materials. These properties are mostly based on well-designed structures that consist of hard particles and softer components that work as a “glue” creating a matrix that binds the hard particles together. The key factors in the nature`s composite materials rely on the bonds and interactions between different elements. Especially interesting are nanocomposite materials that can be designed and tailored to gain superior properties, such as mechanically very tough and strong. My PhD focuses on creating new high performance nanocomposite materials and studying the molecular interactions that lead to macroscale properties.

One promising approach towards high performance composites was demonstrated by Laaksonen et al<sup>1</sup>. In this work a composite material was built by combining nanofibrillated cellulose (NFC) and graphene. By using a specially designed polypeptide the interaction between the NFC and graphene was interlinked and reinforced. The work demonstrated that the excellent mechanical properties of nanoscale components such as NFC and graphene can be made use of for macroscale properties if their interactions are controlled. The polypeptide interactions between the NFC and graphene components are expected to mimic the interactions between hard platelets in nacre. This publication is the starting point of the PhD.

The work is performed in collaboration with the groups of Prof. Markus Linder (Nanobiomaterials, VTT), Prof. Olli Ikkala (Materials science, microscopy, Aalto University), Prof. Janne Laine (NFC, Aalto university), Prof. Ingo Burgert (micromechanical testing, ETH, Switzerland) and PhD Andreas Walther (Biomaterials Science, RWTH Aachen University, Germany).

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<sup>1</sup> Laaksonen, P., Walther, A., Malho, J-M., Kainlauri, M., Ikkala, O., Linder, M.B, Genetic Engineering of Biomimetic Nanocomposites Using Diblock Proteins, Graphene and Nanofibrillated Cellulose .*Angewandte Chemie, Int. Ed* (2011) DOI: 10.1002/anie.201102973, Volume 50, issue 37, pages 8688-8691