

Plenary Talk

PV III Mon 17:00 HSZ 01

Nature's Materials – hierarchical structure and mechanical properties — ●PETER FRATZL — Max Planck Institut of Colloids and Interfaces, Potsdam

A large variety of natural materials with outstanding mechanical properties have appeared in the course of evolution. This includes wood, grasses, bone, sea shells or glass sponges. Biological materials are generally composites of different types of polymers and – sometimes – mineral. They are built in a hierarchical fashion, which allows the material to be optimized for its function at many different structural levels.

Bone, for example, consists in about equal amounts of a collagen-rich matrix and calcium-phosphate nano-particles. These components are joined in a complex hierarchy of fibres and lamellar structures to a material with exceptional fracture resistance. Studying bone us-

ing methodologies borrowed from materials physics improves the basic understanding of its hierarchical structure and in relation to its properties and function, but it may also help in understanding the effect of diseases and therapies, e.g., in the context of osteoporosis or bone healing.

Glass sponge skeletons are another example where a minimum amount of protein dramatically reduces the inherent brittleness of glass. Plant cell walls, on the contrary, are almost fully polymeric composites which are able to generate considerable stresses and even complex movements with changing humidity. These actuation capabilities are based on intricate cellulose fibre architectures and the water swelling of hemicelluloses. Unravelling the structural principles of these unexpected material properties may help in the understanding of these biological systems but also indicate ways on how to develop new types of biomimetic materials with exceptional properties.