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SEMINAR

aus

Halbleiterphysik und Nanotechnologie

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Hörsaal für Physik

"Wood swelling with humidity: an EOS approach using the concept of force balance"

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Wood consists of parallel, hollow, cylindrical cells. The so-called "wood material", i.e. the materials the cell walls are made of, is a complex, highly anisotropic and hierarchically organized nancomposite. It is characterized by stiff cellulose nanofibers parallel to each others embedded in a matrix of a much softer, less anisotropic, macromolecules (hemicelluloses and lignin). The matrix is hygroscopic and swells with increasing relative humidity. This swelling is normally described as arising from the H-bond interactions of water molecules with the hydrophilic poly-saccharides and the sorption isotherms interpreted with modified BET, Dent, HH or GAB models. Although those expressions fit the sorption data excellently, they do not take into account neither the structure of the composite at the nanometric scale nor its hierarchical arrangement. In this work, we explore the possibility that, at the molecular level, the force driving water sorption in wood is mainly the hydration force. Considering a hexagonal arrangement of the wood material's building blocks at the two molecular levels (cellulose nanocrystals and single polysaccharide chains of the matrix) and taking into account the current wood structural models, we attempt a balance between chemical, colloidal and mechanical forces. From the force terms, the osmotic pressure is computed within the unit cell and the theoretical sorption isotherm calculated. The results of the model, compared with experimental sorption data and with small angle X-rays and neutron scattering data, seem to capture the main features of the wood swelling by water.