AFM as a universal tool in paper research

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Wood pulp fibers are used in paper and packaging applications and are, therefore, an irreplaceable part of our daily life, but their mechanical properties are not well understood. Due to their complex hierarchical structure, pulp fibers have anisotropic properties. Furthermore, the processing and the fiber's hygroscopic nature result in a very rough surface, where the roughness and the mechanical properties change with humidity.

We will show how atomic force microscopy (AFM) measurements of single fibers and single fiber to fiber bonds impacted the current understanding of the binding mechanisms between the fibers in paper. Based on the broad investigation of paper fibers with AFM methods we were able to shed light into the bond between the paper fibers at the µm and nm range.

As a classic technique, single fiber tensile testing is most often used to determine the elastic modulus in longitudinal fiber direction, however, the transverse fiber direction is inaccessible to most methods. Here, AFM demonstrates how powerful it is. AFM not only enables access to the longitudinal fiber direction but can overcome the surface roughness of the fiber by local measurements on the nanoscale and allows the probing of the transverse fiber direction.

In this talk, the experimental approach to apply AFM-based nanoindentation studies on pulp fibers will be presented and a timeline will highlight the most important AFM-driven achievements in micromechanical characterization of pulp fibers.