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A tensile stage for synchrotron-based infrared microspectroscopy at ALBA

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For the study of thin films and fibres under load, a uniaxial tensile stage has been developed. The stage has been designed with several key features for tensile load experiments at synchrotron-based polarised infrared microspectroscopy endstations. One of the advantages compared to commercial available stages is its compact design (<20 mm thickness) and the large field of view on the sample for transmission experiments (75 mm x 20 mm). The unique design allows placing the stage at the focal position of an infrared microscope with typically small working distances of only around 10.5 mm, using one of the highest magnification objectives (36x, NA= 0.52) allowed by the IR microscope optical design. In addition, the stage was designed in a way that it is possible to rotate between -15° and +193° in the sample plane, in order to rotate the sample relative to the fixed polarisation direction of the incoming infrared light from the synchrotron source. This feature allows performing synchrotron-based polarised FTIR microspectroscopy for the analysis of vibrational band orientation in stretched samples. Furthermore, the stage can be sealed for atmospheric control of the sample. Preliminary in situ tensile load experiments conducted at MIRAS beamline of the ALBA synchrotron were done using 3D printed polymer thin films and fibres as test samples. The samples could be mapped in transmission geometry under tensile load achieving the highest spatial resolution between 3 to 10 microns. Making use of the polarised synchrotron-based infrared light, it was also possible to show the alignment of different vibrational bands parallel and perpendicular to the stretching direction. The experiments highlight the unique instrumentation capabilities of the tensile stage for in situ measurement of chemical distributions and molecular orientations as a function of sample displacement and applied load. The stage is now part of the user program at MIRAS, the infrared microspectroscopy beamline of ALBA.

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