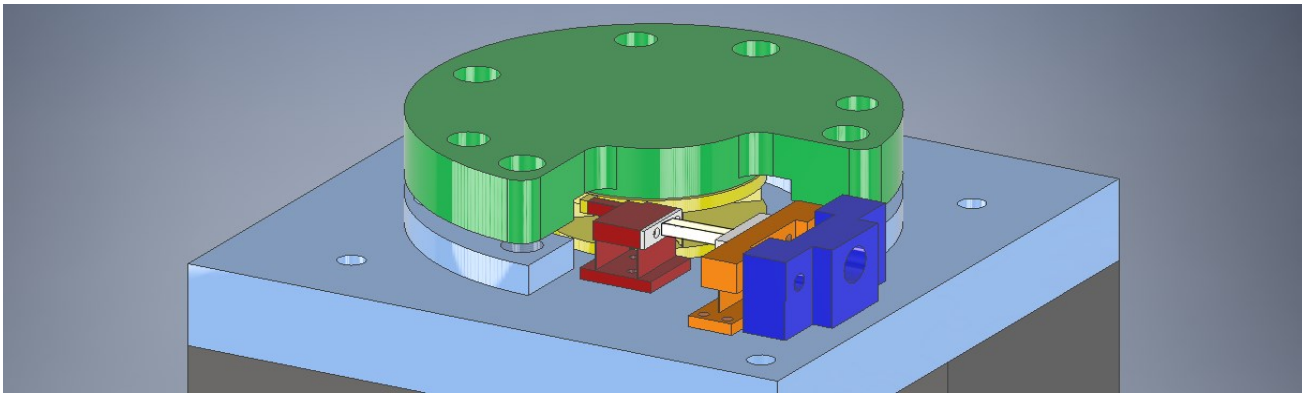
ETH zürich

Licensing Opportunity

High-frequency shear rheometer for characterizing colloidal dispersions and polymer melts



Shear rheometer with two circular plates, separated by X-shape flexures (yellow). A stack of piezo crystals (white) drives the oscillatory motion.

Application

This high-frequency rotational shear rheometer analyses local-scale viscoelastic properties and fast dynamics of complex fluids, such as the dispersion state of colloidal dispersions or segment dynamics in polymeric systems. It operates as a stand-alone device. Its components also integrate easily into commercial shear rheometers and, thus, extend the available frequency range in a continuous manner.

Features & Benefits

- Operating frequency from 20 - 2'000 Hz
- Operating temperature up to 150°C (above the glass temperature of many polymers)
- Measures viscoelastic moduli up to 1 MPa

Publication

- "Stress Contributions in Colloidal Suspensions: The Smooth, the Rough, and the Hairy", *Phys. Rev. Lett.* ***2019***, 218001 (10.1103/PhysRevLett.122.218001)
- Patent pending WO2021089451A1

transfer

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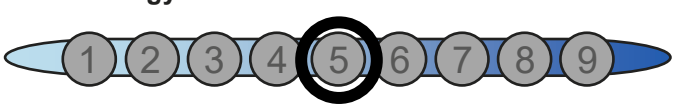
Technology Readiness Level



Background

Conventional rotational rheometers typically operate below 50 Hz and probe slow and larger-scale phenomena. A continuous extension of the frequency range for the measurement of thermorheologically complex samples poses new machine requirements, which the existing rheometers do not offer - in particular: The inertia of the overall measurement unit has to be lowered, resonance frequencies in the new high-frequency range must be avoided, and the gap, which holds the sample, needs to be reduced to achieve higher measurement accuracy.

Invention

The high-frequency rotational shear rheometer is a stand-alone, mechanically robust and temperature-resistant device which measures the viscoelastic shear properties of a given sample. The sample is loaded between two plates: The bottom plate is used both for driving and detecting. The top plate acts only as a reflector and can therefore also be a geometry inside a commercial rheometer. A stack of piezo crystals touching the bottom plate tangentially controls the deformation and measures the force. X-shape flexures between the two plates convert the translational movement of the piezo stack into rotational motion. Using a sintered stack of thin plates increases both the sensitivity for force detection as well as the stack operating temperature. Additional flexures reduce parasitic deformations. An alternating voltage drives the piezos and induces a homogeneous, oscillatory flow profile in the sample (operation within gap loading limits). The output current is generated by the piezo resulting from the mechanical force exerted on it. Magnitude and phase are measured using a Lock-in amplifier. The system needs calibration with the plates unloaded.