ShearView: An Open-Source Compact Rheometer for Integrated Rheo-Microscopy

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Understanding the microscopic origin of the rheological response of complex fluids requires instruments capable of simultaneously measuring macroscopic mechanics and microscopic structure. However, commercial rheo-microscopy platforms are often expensive, bulky, and difficult to customize, limiting their accessibility and integration with advanced optical techniques.

Here we present ShearView, a compact, low-cost, and fully open-source linear rheometer designed for integrated rheo-microscopy. The instrument combines stress- and strain-controlled operation with optical transparency and compatibility with standard upright and inverted microscopes. ShearView is constructed primarily from off-the-shelf components and is operated through custom control software implementing dual feedback loops for either imposed strain or imposed stress.

The platform enables the application of arbitrary shear waveforms, including sinusoidal, large-amplitude oscillatory shear, chirped, and transient protocols, while simultaneously acquiring synchronized microscopy images. Calibration and control procedures provide accurate and reproducible operation over a broad range of frequencies and deformation amplitudes. Validation against a commercial rotational rheometer shows excellent agreement in both linear viscoelastic frequency sweeps and nonlinear oscillatory shear measurements.

We further demonstrate the capabilities of ShearView through representative rheo-microscopy experiments, including echo, recovery, and shear-cessation protocols, in which the rheological response is directly correlated with the evolution of the sample microstructure. These experiments highlight the potential of the instrument to investigate yielding, restructuring, memory effects, and flow-induced organization in colloidal and other soft-matter systems.

By combining mechanical simplicity, modularity, and open access to hardware designs and software, ShearView provides an accessible platform for scattering, imaging, and rheological studies of complex fluids, with applications ranging from research laboratories to teaching environments.

Keywords:
rheology, rheometry, rheo-microscopy, complex fluids, colloids, soft matter, open-source instrumentation, yielding

Schematic view of ShearView platform integrated on an inverted optical microscope. The compact linear rheometer is mounted around the sample stage and coupled to a computer for real-time acquisition and control.

References:

[1] Nikolaos Kalafatakis, Roberto Cerbino; ShearView: A compact stress- and strain-controlled linear rheometer for integrated rheomicroscopy. J. Rheol. 1 January 2026; 70 (1): 165–181. https://doi.org/10.1122/8.0001101

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