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Viscosimetry using a new electromagnetic-acoustic microbalance

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The nanostructure evolution of gels, biomaterials or porous media can be characterized by its mechanical properties. Few non-destructive techniques are developed to investigate the viscosity evolution. This paper present a new electromagnetic-acoustic technique using a wireless thickness shear mode transducer. A suitable model of the measurement is also presented to characterize the viscosity of the nanostructure in contact with the transducer.
This transducer is a double copper-clad PVDF substrate resonator, designed to operate over a wide radiofrequency range without lumped tuning capacitors. This architecture constitutes an alternative solution to design a high-Q ultrasonic microbalance. To characterize the material at the surface of the transducer, the evolution of the induced complex impedance is measured. From this evolution, the mechanical energy storage and dissipation in the material can be extracted.
In order to validate the lumped element model used, a series of glycerol/water mixtures is studied. We show that the resonant frequency shift and damping follow an accurate linear shape (<5%) according to the square root of the liquid viscosity and density product. This result is in good agreement with the classical prediction of Martin and Kanazawa obtained with a quartz crystal microbalance.