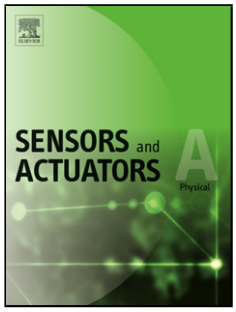

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A contact resonance viscometer based on the electromechanical impedance of a piezoelectric cantilever

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Highlights

- A contact resonance viscometer based on the electromechanical impedance of a piezoelectric cantilever was proposed and fabricated
- The electromechanical impedance of the cantilever-fluid system was derived by using an equivalent circuit model
- The performance of the sensor was evaluated in a wide range of viscosity (10cp-2000cP)
- The sensor featured in-plane vibration mode, high quality factor and self-sensing characteristic
- The proposed method is very promising for online viscosity measurement, especially for high-viscosity fluids

Abstract: In this work, we proposed a self-sensing contact resonance viscometer based on the electromechanical impedance of a piezoelectric bimorph cantilever whose free end is perpendicularly attached by a sensing slice. During measurement, the sensing slice is immersed into the fluid and excited in-plane vibration by the piezoelectric cantilever. The mechanical impedance from the fluid load is analyzed and the electromechanical impedance of the cantilever-fluid system is derived by using an equivalent circuit model. Then we track the electric impedance of piezoelectric bimorph to extract the dynamic viscosity of the testing fluid, based on the shift of the resonance frequency and the quality factor. Calibration experiments were carried out using glycerol-water solutions with different concentrations (10~2000cP). Finally, the viscosities of olive oil and silicon oil were measured using the calibrated curves, and the results coincided with that given by the standard viscometer. The proposed method is very promising for online viscosity measurement, especially for high-viscosity fluid, due to its high quality factor and self-sensing characteristic.

Keywords: viscometer; piezoelectric cantilever; electromechanical impedance; quality factor; equivalent circuit

1. Introduction

The viscosity of fluid is one of the most essential rheological parameters, and it often requires online measurement to monitor the productive process in various industries such as chemical, biomedical, oil, and food, etc. For example, the real-time monitoring of blood

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