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A Multi-Phase Based Fluid-Structure-Microfluidic interaction sensor for Aerodynamic Shear Stress[1] CHRISTOPHER HUGHES, American Nanofluidics LLC, DIGANTA DUTTA[2], YASHAR BASHIRZADEH[3], KAREEM AHMED, SHIZHI QIAN, Old Dominion University — A novel innovative microfluidic shear stress sensor is developed for measuring shear stress through multi-phase fluid-structure-microfluidic interaction. The device is composed of a microfluidic cavity filled with an electrolyte liquid. Inside the cavity, two electrodes make electrochemical velocimetry measurements of the induced convection. The cavity is sealed with a flexible superhydrophobic membrane. The membrane will dynamically stretch and flex as a result of direct shear cross-flow interaction with the seal structure, forming instability wave modes and inducing fluid motion within the microfluidic cavity. The shear stress on the membrane is measured by sensing the induced convection generated by membrane deflections. The advantages of the sensor over current MEMS based shear stress sensor technology are: a simplified design with no moving parts, optimum relationship between size and sensitivity, no gaps such as those created by micromachining sensors in MEMS processes. We present the findings of a feasibility study of the proposed sensor including wind-tunnel tests, microPIV measurements, electrochemical velocimetry, and simulation data results. The study investigates the sensor in the supersonic and subsonic flow regimes.

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