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Performance of a Photonic Wall Shear Stress Sensor[1] ULAS AYAZ[2], TINDARO IOPPOLO[3], VOLKAN OTUGEN[4], Southern Methodist University — The performance of a photonic wall shear stress sensor prototype based on the so-called whispering gallery modes (WGM) of polymeric microspheres is investigated in steady and unsteady flows. In this sensor, the shear force due to the fluid flow is transmitted to a Polydimethylsyloxane sphere of several hundred microns in diameter which serves as the sensor. The corresponding optical resonance (WGM) shifts are monitored to determine the wall shear stress. Sensor performance for dynamic range, resolution and bandwidth are studied analytically, and validated experimentally. The validation experiments for the prototype sensor with measurement area of $1mm^2$ are made in a two-dimensional channel flow and in an acoustic plane wave tube. These measurements indicate a shear stress resolution of $\sim 10^{-3}$Pa and a dynamic range of $\sim$100dB for the prototype. The PDMS sphere used in the prototype has a base-curing-agent ratio of 40:1. Different sensitivities and measurement ranges can be obtained using different PDMS mixing ratios.

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