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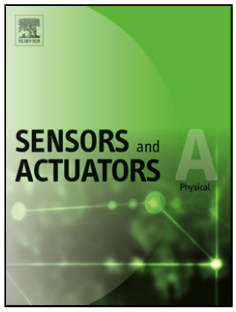

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Non-intrusive Measurement of Wall Shear Stress in Flow Channels

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Highlights

- Fourier transform traction cytometry (FTTC) was used to extract the wall shear stress field of PDMS flow channels from the displacement field of a wall coated with soft silicone.
- This approach introduces a non-intrusive direct method of shear stress measurement for flow channels.
- The method showed its applicability for a range of flow rates under Poiseuille flow regime in rectangular channels.

Abstract

Flow shear stress measurement plays an important role in the characterization of macro and micro fluidic systems. Many currently used wall shear sensors quantify local shear stress with the use of fluid-disruptive probes, unless installed accurately flush to the channel surface. Non-intrusive shear stress measurement systems capable of quantifying the shear stress vector field in larger areas are highly desirable. The present study reports on non-intrusive direct measurement of wall shear stress under pressure-driven fluid flows with the use of particle imaging velocimetry and Fourier transform traction cytometry. This method uses the known mechanical properties of a soft substrate strained under the flow to quantify the shear stress field. Under fully developed pressure-driven laminar flows of different flow rates in a rectangular channel, the average magnitude of wall shear stress thus obtained matched with the theoretical results obtained for Poiseuille flow. The major advantage of this method is the direct experimental characterization of wall shear stress vector field without disruption of the flow itself. The method shows promise in the characterization of shear flow in diverse areas such as aerospace and bioengineering.

Keywords: Wall friction, PIV, Fourier transform, Traction force microscopy

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