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An Accurate Velocity Profile Measurement System for Microfluidics: A Direct Measurement of the Slip Length

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We describe an accurate method to measure velocity profiles in thin microchannels, using particle image velocimetry combined with a nano-positioning system. The experimental setup is used to measure the slip length for water flowing along an hydrophilic surface, pyrex glass, and an hydrophobic one, a monolayer of octadecyltrichlorosilane on silicon. This method has a few percent precision on the velocity, 100 nm-accuracy on the determination of the wall position, and a similar precision for the position of the fluid layer where the measurement is performed. These characteristics allow to determine, with unprecedented accuracy ($\pm$100 nm), slip lengths for water flows over glass; this represents a substantial improvement (a factor of 6 or so) compared to previous work using a direct method. When applied to glass surfaces, one gets slip lengths equal to 0$\pm$100 nm. For functionalized silicon surfaces, the accuracy is lower. One obtains 200$\pm$300 nm in this particular case.

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