

MINIATURE AND MICRO-DOPPLER SENSORS

by

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Abstract

Recent advancement has resulted in the miniaturization of laser Doppler sensors for the measurement of flow velocity and wall shear stress. In particular, the design and the performance of a Miniature laser Doppler anemometer, a miniature particle sizing sensor, and an optical shear stress sensor based on micro-optical electromechanical systems (MOEMS) is reviewed.

The Miniature LDA (See Figure 1) uses a diode laser, diffractive optical element and miniature optics resulting in a rugged, small and self-contained backscatter LDA with frequency shifting. It has a fixed probe distance, and except for a rotating diffraction grating, has no moving or adjustable parts. It has a dimension of 50 mm in length and 25 mm in diameter. Sensors with different fringe sizes and sensor f-numbers have been fabricated.

By incorporating a second laser and modifying the collection optics of the miniature LDA, a miniature particle sizing probe for spherical and non-spherical particles was fabricated. The particle sizing is achieved by the "IMAX" technique. The sensor is capable of sizing particles from a micron to 100's of microns. The dynamic range is limited by the dynamic range of the linear or log detector. Addition of a second detector allows the sensor to measure droplet size using the "Phase Doppler" technique.

Further miniaturization of the laser Doppler sensor was achieved by the fabrication of integrated optics on a single substrate. Micro-Devices technology was used for the integration of curved diffractive optical elements on a single substrate. As an initial demonstration of the technology, an optical shear stress sensor was fabricated. In this sensor, four optical elements were printed on a single silicone substrate. Using a diode laser, an optical fiber, and the substrate, an optical shear sensor was fabricated. The sensor has a dimension of 15 mm in diameter and 20 mm in length.



Figure 1. Photograph of a miniature laser Doppler anemometer.

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Miniature And Micro Doppler Sensors

Scott C. Dulebohn



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