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A thermal sensor for minimally invasive blood flow assessment

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Introduction

Accurate hemodynamic measurements are required to assess the functional significance of coronary artery disease. In contrast to pressure, accurate flow measurement in coronary arteries is still a major challenge.

In previous studies, a flexible flow sensor to be bent around a guide wire has been designed [1] and manufactured [2]. Here, the first flow experiments with the sensors on a flat surface, are presented.

Methods

The sensor consists of two thermopiles (Fig. 1) measuring the temperature difference between $T_d$ and $T_u$ and between $T_h$ and $T_f$. The heater is controlled such that $T_h-T_f$ remains constant at 5K. The power required is then used as a measure for the shear rate.

The flexible sensors are mounted across a channel, through which flow/shear rate can be applied to the sensors (Fig. 2). Two types of shear rates were used to characterize the sensors: Sinusoidal shear rates with different amplitudes ($A = 500,1000,2000$ s\(^{-1}\)) and frequencies ($f = 1/3,1,2$ Hz) and typical shear rate dynamics found in coronary arteries.

Results & Conclusion

Fig. 3 demonstrates that, in a sinusoidal shear rate, the power is a good measure for the shear rate and that $T_h-T_u$ can be used to detect shear rate reversal.

By constructing a quasi-steady calibration relation between the shear rate and power, valid for all nine sinusoidal shear rates, the shear rate could be measured for a coronary-like shear rate (Fig. 4).

Conclusion: The first experiments clearly demonstrate that the flexible sensors are suitable for shear rate assessment.

References