

## Development of a micro-optofluidic temperature sensor

**Citation for published version (APA):**

Sharma, M. K., Frijns, A. J. H., Janssen, T. W. M., Mandamparambil, R., & Smeulders, D. M. J. (2015). Development of a micro-optofluidic temperature sensor. In A. Vasdekis, & M. Psaltis (Eds.), *Proceedings of the 3rd EOS Conference on Optofluidics (EOSOF 2015), 21-25 June 2015, Munich, Germany*

**Document status and date:**

Published: 01/01/2015

**Document Version:**

Accepted manuscript including changes made at the peer-review stage

**Please check the document version of this publication:**

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.tue.nl/taverne](http://www.tue.nl/taverne)

**Take down policy**

If you believe that this document breaches copyright please contact us at:

[openaccess@tue.nl](mailto:openaccess@tue.nl)

providing details and we will investigate your claim.

# Development of a Micro-optofluidic Temperature Sensor

M.K.Sharma,<sup>1</sup> A.J.H. Frijns,<sup>1</sup> T.W.M Janssen,<sup>1</sup> R. Mandamparambil<sup>2</sup> and  
D.M.J Smeulders<sup>1</sup>

<sup>1</sup>Eindhoven University of Technology, Dept. of Mechanical Engineering, Eindhoven, 5600MB,  
The Netherlands

<sup>2</sup>TNO, Eindhoven, 5612AP, The Netherlands

email: [M.K.Sharma@tue.nl](mailto:M.K.Sharma@tue.nl)

## Summary

A fluorescent micro-optofluidic temperature sensor is developed using a temperature sensitive dye. The sensor can measure temperatures in microregions up to 70 °C and is applicable in lab-on-a chip devices. It is fabricated using soft lithography method and uses Rhodamine B dissolved in water as a temperature indicator.

## Introduction

Temperature measurement is an important issue in almost all fields of physics, chemistry and biology. Recent developments in the field of micro-electro mechanical systems (MEMS) have increased the interest of miniaturized optical sensors with additional system functionalities. The increasing use of a polymer called poly (dimethylsiloxane) (PDMS) in microfluidic device fabrication has made the temperature measurement prominent due to the low thermal conductivity. Polymer fabrication techniques [1] [2] of integrating optical elements into microfluidic devices have several advantages in terms of simplicity and cost reduction [3]. One of the optical sensor platforms is based on molecular fluorescence. An aqueous solution of Rhodamine B dye exhibits an inverse dependency of its fluorescence intensity on temperature [4] [5].

In this work a polymer based approach is used to fabricate microfluidic channels in PDMS with SU8 as a patterning layer. Optical fibers are integrated into the channel for coupling-in and -out of light. A laser (Thorlabs) operating at 532 nm wavelength and at a maximum power of 4.5 mW is used as an excitation source and a spectrometer (Torus, Ocean Optics) is used to collect the emission intensity. Figure 1(a) shows the image of a fabricated device and figure 1(b) demonstrates the excitation and emission of Rhodamine B.

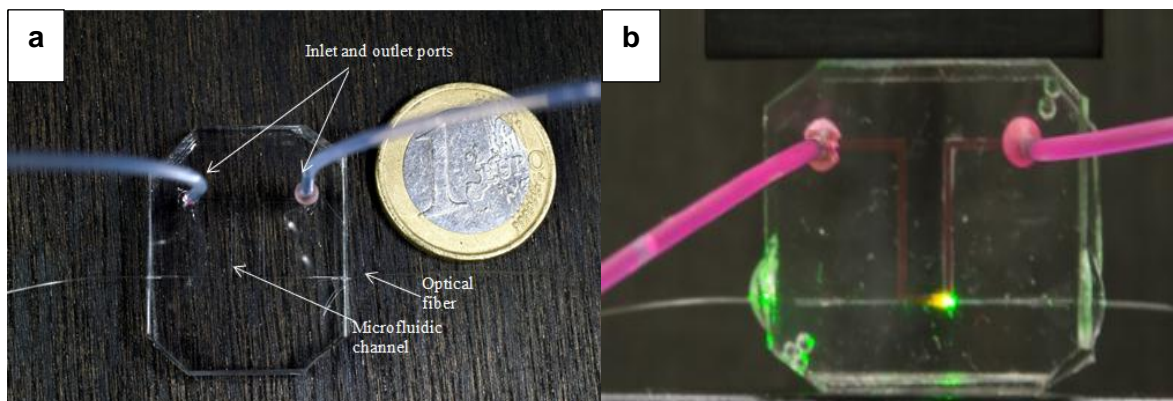


Fig. 1(a) Image of a microchip with integrated optical fiber and fig. 1(b) image of a device showing fluorescence of Rhodamine B

## Discussion

An aqueous solution of Rhodamine B is prepared with a concentration of 1mM and used for the temperature measurement in this experiment. The chip is placed on a hot plate and a thermocouple (K type) is inserted in the chip. The liquid is preheated in a glass syringe to heat the solution before it is injected into the microchannel. In this way the absolute temperature difference between liquid and the device is reduced and the temperature can be adequately prescribed. The fluorescence intensity decay is linear. In order to verify the effect of Rhodamine B adsorption into the PDMS channel which ultimately affects the temperature measurement, a glass capillary channel similar to the PDMS chip is made and the experiments are repeated in the similar fashion. The temperature dependency in this case is also linear. Finally, error analysis is done and the results of the PDMS chip and the glass capillary is compared. It is noted from the results that the adsorption of Rhodamine B into the PDMS channel does not affect the temperature much because of the continuous replenishment of the solution into the microchannel.

## Conclusions

A micro-optofluidic temperature sensor with integrated fiber is fabricated using a soft lithography technique. An aqueous solution of Rhodamine B is used as a temperature index. The experiment is conducted on PDMS and glass capillary. The results are compared and show a linear decay in fluorescence intensity as a function of temperature. It is a promising approach for application in lab-on-a-chip devices.

## References

- [1] K. B. Mogensen, J. El-Ali, A. Wolff, and J. P. Kutter, Integration of Polymer Waveguides for Optical Detection in Microfabricated Chemical Analysis Systems, *Appl. Opt.*, **42**, 4072, 2003.
- [2] P. Friis, K. Hoppe, O. Leistiko, K. B. Mogensen, J. Hübner, and J. P. Kutter, Monolithic integration of microfluidic channels and optical waveguides in silica on silicon., *Appl. Opt.*, **40**, 6246–51, 2001.
- [3] K. B. Mogensen and J. P. Kutter, Optical detection in microfluidic systems., *Electrophoresis*, **30** Suppl 1, S92–100, 2009.
- [4] L. Gui and C. L. Ren, Temperature measurement in microfluidic chips using photobleaching of a fluorescent thin film, *Appl. Phys. Lett.*, **92**, 024102, 2008.
- [5] J. Sakakibara and R. J. Adrian, Whole field measurement of temperature in water using two-color laser induced fluorescence, *Exp. Fluids*, **26**, 7–15, 1999.