Advanced Micro-machining of Optical Fibre Cantilever Sensor
J. Li, F. Albri, J.N. Su, R.R.J. Maier, W.N. MacPherson, D.P. Hand

Introduction

Micro-cantilever sensors are attracting much attention as promising solutions for highly sensitive detection of bio-sensing elements without the need for fluoroscent or radioactive labeling. Bio-molecules are selectively attracted to one side of the cantilever only. Attached molecules induce mechanical bending which can be precisely detected using optical methods that are routinely used for atomic force microscopy (AFM). However, conventional AFM techniques involve bulky optical beam detection systems that are unsuitable for in-vivo measurements.

Optical fibres are ideal medium for high accuracy deflection measurements using optical interferometry. In this research we aim to manufacture micro-cantilevers onto the end of an optical fibre thereby combining the sensing element and the interrogation system into one compact device to enable bio-sensing applications in space constrained environments.

We first use a ps-laser to machine a ridge on top of a SMF-28 corning fibre, together with FIB is employed to fabricate a fibre top cantilever.

Fabrication Process

Micro-machining of fibre top cantilever
Previous work [1] reports Focused Ion Beam (FIB) machining for fabricating optical fibre cantilevers. Here the combination of ps-laser machining techniques together with FIB is employed to fabricate a fibre top cantilever.

We first use a ps-laser to machine a ridge on top of a SMF-28 corning fibre, then use FIB to remove part of the material inside the ridge forming a suspending cantilever structure.

Fabrication of fibre side cantilever

The aim of fabricating cantilever on side of an optical fibre is finally try to manufacture a 3D optical probe with a multi-core fibre for biomedical application.

Micro-cantilever machining with bio-molecules attached onto its surface;
Left static mode, right dynamic mode (Courtesy of Lifan Liu)

Fabrication of fibre side cantilever

Micro-cantilever with bio-molecular attached onto its surface.
Left static mode, right dynamic mode (Courtesy of Lifan Liu)

Optical fibre cantilevers. Here the combination of ps-laser machining techniques greatly reduced the machining time while maintaining a good surface quality.

Conclusion and future work

We experimentally demonstrated the possibility of machining micro-cantilever onto the end of an optical fibre using ps-laser and FIB. The combination of the two machining techniques greatly reduced the machining time while maintaining a good surface quality.

Further study will include an on-line monitoring system for fibre side cantilever which could optimize the 45˚ angle and maximize the reflection power. In addition, investigation into further data processing to improve resolutions is also planned.

Finally, we will try to reduce the surface finish of ps-laser machining and make laser directly machining of a fibre cantilever possible.

Acknowledgement

We thank SUPA for giving a studentship to J.Li and Reinislaw plc. for supporting of this project.

Reference

Authors contact information: jll294@hw.ac.uk

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Left static mode, right dynamic mode (Courtesy of Lifan Liu)