ANFF

ACT Node & WA Node NEWS

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ACT Node & WA Node

Issue No. 6

December 2010

MEMS-based chemical and bio-sensor arrays

The Microelectronics Research Group at the ANFF WA Node has been working on next-generation optical read-out techniques for micro-electro-mechanical system (MEMS) based biological sensors. Specifically, they are working on various optical techniques which will provide methods for actuating and interrogating incredibly large arrays of micro-cantilever-based MEMS sensors. Using these techniques should provide the ability to build chips containing multi-system, multi-analyte sensors with zepto-gram (10^{-21}g) accuracy.

It is currently possible to build biological sensors using micro-cantilever beams coated with substances specifically designed to bond to whichever chemical substance it is desired to detect. There are two common modes of operation of micro-cantilever sensors. The first is static, where the preferential adsorption of an analyte onto the coated surface causes the cantilever to bend; with the second being dynamic, where the adsorbed analyte changes the mass of the beam and hence its mechanical resonant frequency. The difficulty lies in interrogating the state of these cantilevers in order to determine whether a detection event has occurred. The readout technologies are primarily based on optical techniques developed for atomic force microscopy analysis, in which light is reflected from the cantilever tip to a distant quadrant detector systems and are too large for on-chip integration. The interrogation mechanisms in current commercial systems allow for only 5-10 micro-cantilevers per chip. We wish to increase this by one or two orders of magnitude and improve the statistical detection properties of this class of sensors.

To this end, two separate optical techniques are being tested. In the first technique the sensing cantilever beams are also used as optical waveguides (see Figure 1). When the cantilever moves, the coupling of the light through the waveguide is modulated, and the cantilever motion is transferred on to the output optical signal. The second technique uses the cantilever beam as a reflector above a diffraction grating fed by a waveguide – creating an optically resonant cavity. In this case the cantilever motion modulates the optical signal within the waveguide via constructive or destructive

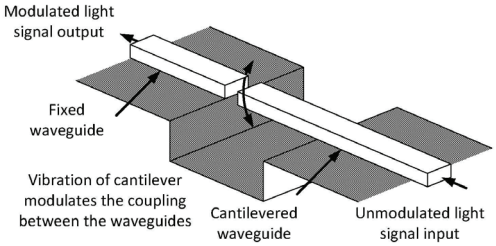
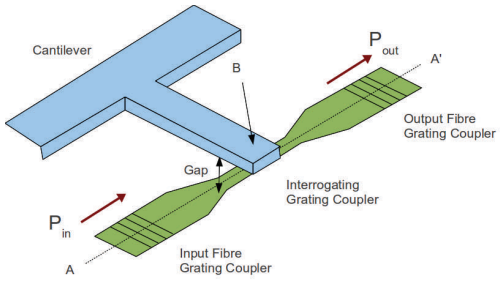
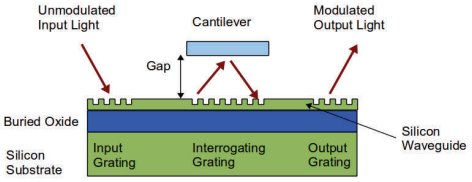


Figure 1 (above). Schematic view of a structure that converts mechanical motion into amplitude modulated optical signal.

Figure 2 (below) Isometric and cross-sectional views of the interrogation structure based on diffraction gratings.





interference within the resonant cavity (Figure 2).

In the ultimate realisation of the proposed technology, the dynamic mode of operation allows multiplexing of multiple signals onto a single optical carrier, a key attribute needed to address large arrays of sensors. The multiplexing approach will form the

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Well, it's that time of year again with people juggling their calendars to fit in all the end-of-year commitments. You may notice the change in the newsletter title, reflecting the fact that the UWA facility is now the eighth node of the ANFF. We have agreed, however, to continue our relationship and produce the newsletter and website in tandem (see story on page two)

Please note the ACT facility will shut down from December 24, reopening on 4 January 2011.

So, as this will be our last newsletter before the end of the year all the staff at the ACT Node and WA Node would like to take this opportunity to wish everyone a very happy and safe festive season and New Year and look forward to continuing our work with you in 2011.

Other news in this issue:

Next Issue: due March 2011

ACT Node & WA Node info:

- The ACT Node specialises in III-V compound semi-conductors.
- The WA Node specialises in II-VI compound semi-conductors and MEMS.
- We can provide full support with the use of the equipment available.
- Full pricing policy and rates are available on the ANFF website at www.anff.org.au or contact us direct for more information - see contact details overleaf.

The Director's Cut

Welcome to the ANFF ACT Node & WA Node newsletter. 2010 has been a very busy year for the Nodes at both the locations (ANU and UWA). All the flagship facilities have been established and operational and been heavily used by the internal as well as external users including industry and international institutions.

These facilities include Dual beam Focused Ion beam System, Nano-imprint Lithography, Electron Beam Lithography, PECVD, ICP-Etching System, RF/DC Sputter System and E-beam/Thermal Evaporator. All staff are on board including joint positions with CUDOS and AMMRF. They are looking forward to assisting you and serving your processing needs. In addition to the flagship facilities, in-kind facilities offered by ANU and UWA are widely used. The Nodes have received an EIF funding allocation which will enable us to upgrade MBE facilities at the UWA facility and install a new GaN MOCVD reactor in 2012-13 at the ANU facility. Ion implantation facilities at the ANU will be further strengthened with full wafer capability in 2011-12.

During 2010, the separate WA Node was established and it will be officially launched in March 2011. This will further strengthen the WA operations. Both WA and ACT Nodes will continue to work together with a joint website, joint newsletter and joint access committee meetings. We hope you will benefit from accessing the facilities at both the Nodes to carry out your research and development.

We want to thank all the users of the Nodes. Special thanks are due to staff of both the Nodes for their dedication and hard work in serving the Nodes and their users.

We wish you all Happy Festive and Holiday Season and we look forward to seeing you in 2011.

C. Jagadish and Laurie Faraone
Directors, ACT Node and WA Node

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basis of a technology for an optical sensor head (incorporating many, potentially thousands of sensors) that is robust, requires no electrical connections, and uses a single optical fibre for addressing and readout (see Figure 3). This allows for many diverse applications – ranging from pesticide detection, to wine quality analysis, to non-invasive lung cancer detection. The ability of this biological sensor to sense multiple different chemicals on the same chip will make these technologies an indispensable tool for any type of biological sensing application in the future.

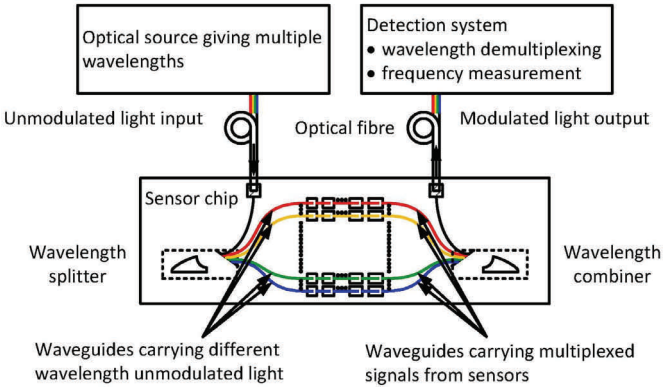

Figure 3. Outline of on-chip optical network used to multiplex information from an array of sensors onto a single fibre output. Row addressing is achieved using wavelength division multiplexing.

Story by Gino Putrino - Microelectronics Research Group, School of Electrical & Computer Engineering, The University of Western Australia.

'New' Website goes live

To coincide with the release of this newsletter, we have launched our 'new' website. Following up on feedback received on the old site we were able to identify some browser incompatibility issues that needed addressing. The changes are evolutionary rather than revolutionary and some of you may not even notice – but it is behind the scenes where the major changes have been made to ensure the site functions consistently across a wide variety of browsers. Our research indicates the three main browsers used are Firefox, Internet Explorer and Chrome – and the new site has been tested across all of these with no issues (please let us know if you find it different!).

Some of the visible changes are a new cascading horizontal menu area that gives us more room on the page for content, the use of Google maps for the facility locations and improved page 'behaviour' when clicking on various links etc. If the link goes to another site, document or specific web page it will open a new browser window or tab (depending on your browser set-up) so you don't need to back-up as much to return to where you left us.

One thing to note is while the 'home page' address is the same (http://anff-act.anu.edu.au) some of the other pages may have a new URL, so if you have any pages bookmarked you may want to check and update them if necessary. As always we would be happy to receive feed-back/comments on the new site.

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