ANFF

ACT Node & WA Node NEWS

Providing nano and microfabrication facilities for Australia's researchers

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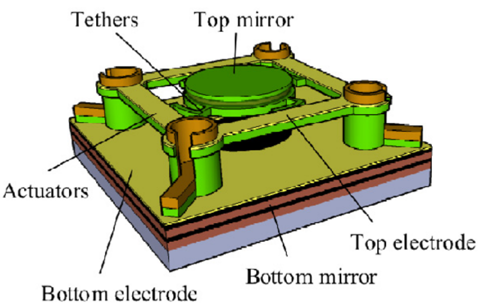
On-chip Imaging Spectrometer - Closer Than You Think

Over the last 15 years the Micro-electronics Research Group (MRG) at the ANFF WA Node has established itself as a leader in MEMS based infrared sensors. The technologies under development are of significant interest to the industry sector with MRG recently securing a $1.5M research grant in this area with the majority of the funding originating with a Fortune 500 defense company in the USA. Another, similarly co-funded, grant of $1.5M has received excellent reviews, and is awaiting final decision by the funding body. This success is made possible by access to the world-class fabrication facilities at the WA node of the ANFF, as well as access to facilities at other ANFF nodes.



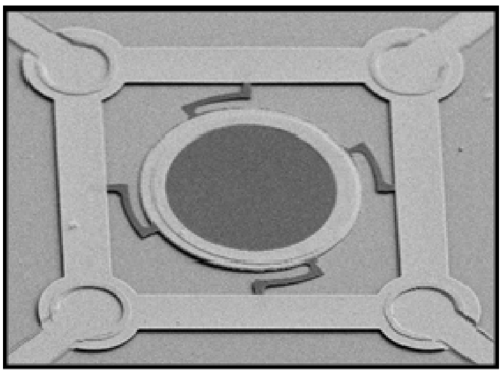


Figure 1a. (top) 3-dimensional schematic layout of micro-spectrometer device, and 1b (above) SEM image showing a fabricated device.

A large part of that work has been focused on the MEMS microspectrometer device depicted in Figure 1. The MRG microspectrometer consists of a tunable MEMS Fabry-Perot optical filter fabricated optically ahead of an infrared detector.

The filter consists of a fixed dielectric bottom mirror, and a moveable dielectric top mirror. Actuation of the top mirror is achieved electrostatically by applying a voltage or charge to the top mirror. Since mirror separation is directly related to the transmitted wavelength of the Fabry Perot filter, actuating the top mirror scans ("tunes") the micro-spectrometer wavelength.

Figure 2 (over) shows that the short-wave infrared (SWIR) microspectrometer devices possess a 50 nm spectral line-width at a centre wavelength of 2 μm, and tune from 1.6 μm to 2.5 μm with a low drive voltage of 23V. Figure 2 also demonstrates that the spectral tuning range can be shifted anywhere in the SWIR and mid-wave infrared (MWIR) range. One of the aims of recent industry co-funded projects is the extension of the operational range of this on-chip spectro-meter well into the visible spectrum.

This technology is now being developed for imaging in remote sensing applications, with the implementation of the tunable optical filter at the focal plane array (FPA) level. Remote sensing plays an increasingly important role in today's world for many applications including, crop monitoring, oil/mineral exploration, disaster monitoring, and surveillance for national security.

Conventional imaging in remote sensing employs either grey-scale or three-colour cameras, with occasional use of mono-chrome infrared imaging. True spectral imaging, in the infrared and visible spectral regions would provide a host of extra information, tremendously assisting the target identification process in these applications. While some true-colour thermal imaging solutions do exist, they rely on a spectrometer external to the FPA, resulting in very bulky, fragile, and power hungry systems, which are ill suited to remote sensing purposes. Another intractable feature of spectral imaging is the sheer volume of information that is collected, much of which is not relevant to the application. This large volume of information renders it impossible to undertake real-time processing or decision-making.

The thrust of this research is to realise, for the first time, an FPA-independent high-performance infrared spectrometer technology, allowing mating to any type of imaging FPA: effectively, an on-chip imaging spectrometer. The proposed

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SuperSaaS Usage of our on-line booking system (used mainly for our Flagship equipment) has been ramping up for some time now since we made it available for registered users to make their own bookings 24/7. We believe this accessibility has been a great improvement for our users as well as making things more streamlined for our own staff. SuperSaaS (the service provider for the scheduling system) are continually making improvements and introducing new features that we have the option of incorporating into our schedules. One of these, that you may not be aware of, is the availability of the system via your Smartphone or other mobile platform (iPad, iPhone, Android tablets or phones etc).

If you have any of these devices just go to the regular URL for our booking system (http://www.supersaas.co.uk/schedule/ANFF_ACT_Node/Flagship_Equipment), log-in with your usual account and give it a try (and save it for future reference). The interface is optimized for the smaller devices, but is still fully functional.

So next time you are out at dinner and you realize you forgot to make that important FIB (or other) booking for next week - now there's nothing stopping you.

Next Issue:
due September 2012

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.

Major US Semiconductor Equipment Manufacturer Engages with ANFF

A leading US semiconductor equipment manufacturer has engaged with the Australian National University and the ANFF for advanced technology research and development. Department of Electronic Materials Engineering researchers at the ANU School of Physics & Engineering and ANFF staff have partnered with a multi-billion dollar leader in semiconductor equipment manufacture, Applied Materials Inc. (NASDAQ:AMAT), to help develop a new generation of non-volatile memory devices for portable electronics. The project is being funded through an ARC Industry Linkage grant with Varian Semiconductor Equipment Associates who were acquired by Applied Materials in November 2011.

Ion implanter at ANU, a key ANFF ACT Node facility used in developing next-generation memory devices.

Professor Robert Elliman, Principal Investigator on the project from the ANU, said: "Specifically the project aims to develop techniques for improving the reliability and endurance of a new class of non-volatile memory called resistive random access memory (ReRAM). These have the potential to provide smaller, faster, and more energy efficient memory that is essential for next-generation portable electronic devices. The Linkage grant with Applied Materials/Varian is turning out to be very successful and may lead to further engagement with the company. The ANFF facilities and expertise have, and will continue to play a critical role in this work."

Applied Materials, Inc. is the global leader in providing innovative equipment, services and software to enable the manufacture of advanced semi-conductor devices, flat panel displays and solar photovoltaic products.

The interaction with Applied Materials provides an important opportunity for Australian scientists and engineers to work at the forefront of semiconductor research, and to showcase Australian expertise and knowhow.

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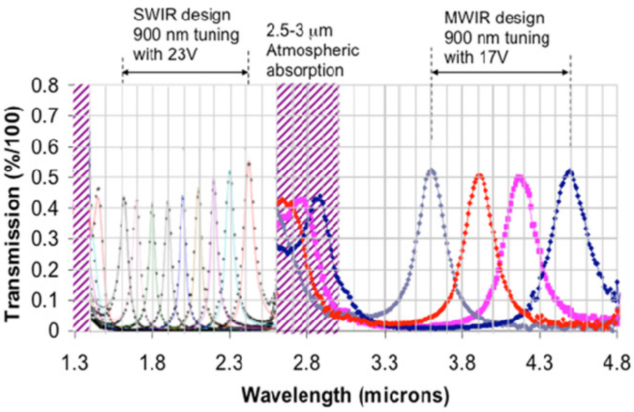

Figure 2. Response characteristics of MEMS spectrometer devices in the SWIR and MWIR wavelength ranges.

imaging spectrometer will be capable of adaptively imaging at any given wavelength, without the need to scan through the entire spectrum.

The key advantages of such a paradigm shift include:

Reduced cost – This technology also has the potential to achieve low unit costs by leveraging the high volume fabrication of the microelectronics/ MEMS industries.

Small size – the tunable filter is of similar size to the image sensor and does not impact the size or weight of an imaging system. This will effectively shrink spectrometer volumes by a factor of $\sim 10^3$.

Robustness – MEMS technology is inherently robust and has a high shock threshold for damage.

Low voltage/power operation – Low voltage operation is essential because the spectrometers are in close proximity to low voltage image sensors. Additionally, the control mechanisms for the spectrometers need to be based on VLSI technology if they are to be truly miniature in size. It is also essential that the control signals be compatible with the VLSI readout integrated circuit (ROIC) technology. This limits voltage signals to less than 30V and current signals to be sub-microampere. Furthermore, particularly for unmanned aerial applications, reduced power consumption is key. As the MEMS device consumes negligible power compared to a traditional spectrometer, this technology holds great promise for such aerial applications.

Reproducible spectra – In sophisticated statistical spectral processing approaches that use multivariate analysis, the transferability of spectral libraries is essential for real-world applications, requiring systems that are intrinsically stable in their spectral acquisition characteristics. The tunable filter characteristics are set at time of fabrication, using highly reproducible semiconductor microelectronics compatible fabrication technologies.

Minimization of acquired data – This MEMS-based technology will allow adaptive image collection only from spectral regions of interest, significantly reducing the signal processing burden and enabling hyperspectral imaging and remote sensing with lightweight, low cost, mobile platforms. This promises to reduce data volumes by a factor of $\sim 10^2$, help improve the spatial resolution of spectral imagery by as much as 10 times, and enable decision making in real time.

It is anticipated that this enabling technology will dramatically lower the entry barriers to spectral imaging applications for numerous diverse users, both governmental and commercial. In turn this can be expected to fuel more innovation in sensor architectures, hyperspectral algorithms and information products.

Story courtesy of Prof. Dilusha Silva, Engineering Manager MRG and Res. Prof. Mariusz Martinyuk, Facility Manager ANFF WA Node.

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