Abstract

An ultra-compact near infrared spectral engine based on a linear variable filter

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Introduction

LVF is a thin-film Fabry-Perot bandpass filter, the thickness of which is intentionally wedged in one dimension such that the centre wavelength of the bandpass is continuously varying across the length of the filter. When the LVF component is attached to a detector array, a miniature spectrometer is realised, enabling handheld, portable, or on-line sensor applications.

Materials and Methods

The NIR spectral engine was built with an integrated light source, 128-pixel element indium gallium arsenide (InGaAs) detector and custom collimating optics. The LVF is brought in close proximity to the detector array and replaces the detector window. The engine weighs less than 50 grams and measures less than 40 mm^3 in size. It can be used in diffuse reflectance or transmission for the measurement of solid or liquid samples respectively.

Results and Discussion

The LVF coating design plays a key role in the final spectral engine performance, specifically in the resolution level achieved, light throughput and cross-talk. We have optimised the LVF design through an iterative process. The original design relied on a more conventional approach consisting of SiO_2 and Ta_2O_5 as the low-index and high-index materials respectively. The second design was modified using a novel coating design approach that resulted in higher out-of-band blocking, reduced shift of the wavelength with angle of incidence, and reduction in the fabrication cost by a factor of three. The third design was further modified to improve the optical resolution from 2% to less than 1% of the centre wavelength of the bandpass filter such that over the 900nm-1700 nm range, the resolution is 9 nm-17 nm. The resolution is controlled by the full width at half maximum (FWHM) of the bandpass filter. Reducing FWHM usually comes with a reduction in transmission level through the LVF. We show that this trade-off is acceptable for the applications tested.

Conclusion

The LVF-based spectral engine will find use in many cost-effective sensing applications requiring field use or real-time testing in applications such as food and pharmaceutical counterfeit detection, law enforcement and other areas in quality monitoring and control.

Reference paper as:
N. O'Brien, D. Favot, D. Friedrich, K. Hendrix, A. Hulse, C. Hruska and M. Von Gunten (2012).Ultra compact near infrared spectral engine based on linear variable filter (abstract), in: Proceedings of the 15th International Conference on Near Infrared Spectroscopy, Edited by M. Manley,C.M. McGoverin, D.B. Thomas and G. Downey, Cape Town, South Africa, p. 250.