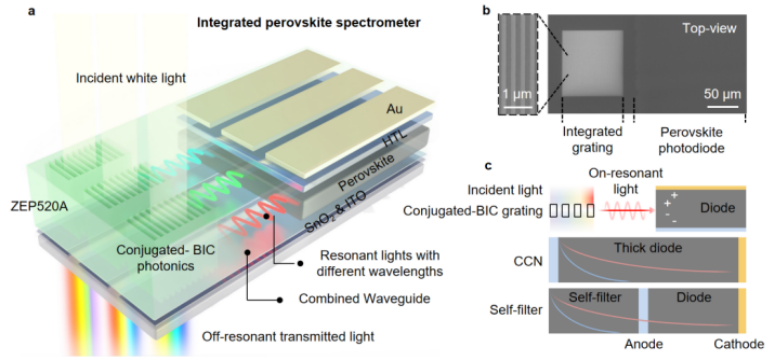
# A platform for integrated spectrometers based on solution-processable semiconductors

FAYETTEVILLE, GA, USA, August 1, 2023 /EINPresswire.com/ -- Novel semiconductors shows hetero-integration capability due to their low-temperature solution processability, which can be potentially be applied in constructing integrated spectrometers. Scientists in China developed a platform for integrated spectrometers by involving the conjugated-mode of the bound states in the continuum and solution-processable semiconductor. The integrated spectrometers are capable of realizing narrowband/broadband light reconstruction and in-situ hyperspectral imaging.

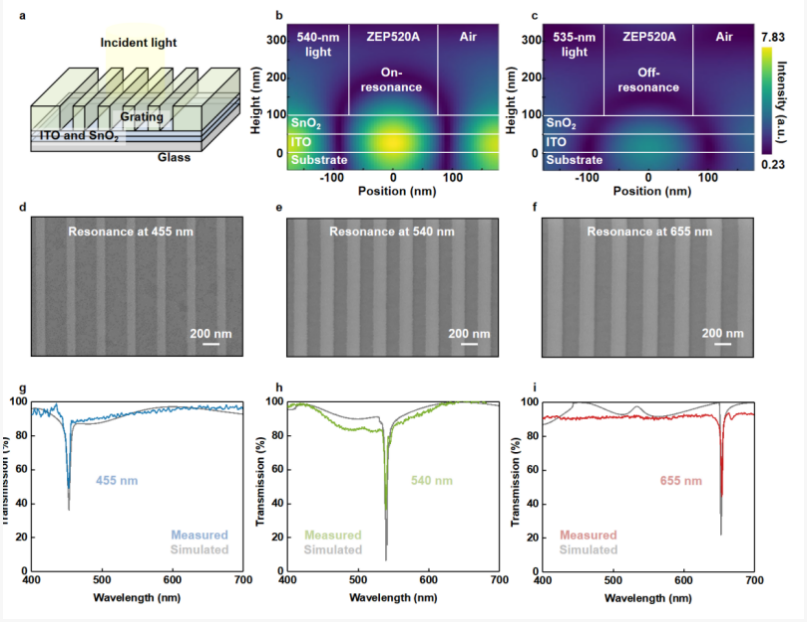



(a) The schematic working mechanism of the integrated spectrometer. Conjugated-BIC photonics and combined waveguides are planarly integrated with perovskite photodiode arrays. Monochromatic light with a specific wavelength can be coupled into the waveguid

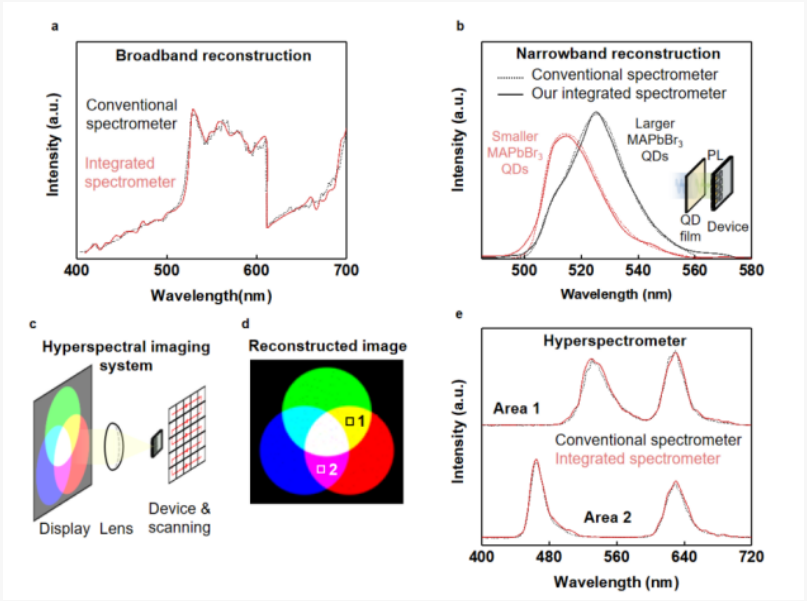
Acquiring real-time spectral information in point-of-care diagnosis, internet-of-thing, and other lab-on-chip applications require spectrometers with hetero-integration capability and miniaturized feature. Compared to conventional semiconductors integrated by heteroepitaxy, solution-processable semiconductors provide a much-flexible integration platform due to their solution-processability, and, therefore, more suitable for the multi-material integrated system. However, solution-processable semiconductors are usually incompatible with the micro-fabrication processes, making them far from practical use in various lab-on-chip applications.

In a new paper published in Light: Science & Applications, a team of scientists, led by Professor Qinghai Song from Ministry of Industry and Information Technology Key Lab of Micro-Nano Optoelectronic Information System, Guangdong Provincial Key Laboratory of Semiconductor Optoelectronic Materials and Intelligent Photonic Systems, Harbin Institute of Technology (Shenzhen), China have proposes a facile and universal platform to fabricate integrated spectrometers with solution-processable semiconductors by unprecedently involving the conjugated mode of the bound states in the continuum (conjugated-BIC) photonics.

Specifically, exploiting the conjugated-BIC photonics, which remains unexplored in conventional lasing studies, renders the broadband photodiodes with ultra-narrowband detection ability, detection wavelength tunability, and on-chip integration ability while ensuring the device performance. Spectrometers based on these ultra-narrowband photodiode arrays exhibit high spectral resolution and wide/tunable spectral bandwidth. The fabrication processes are compatible with solution-processable semiconductors photodiodes like perovskites and quantum dots, which can be potentially extended to conventional semiconductors. Signals from the spectrometers directly constitute the incident spectra without being computation-intensive, latency-sensitive, and error-intolerant. As an example, the integrated spectrometers based on perovskite photodiodes are capable of realizing narrowband/broadband light reconstruction and in-situ hyperspectral imaging. The reported platform provide insight into constructing integrated spectrometers with multi-material integrated system.




(a) Schematic model of the conjugated-BIC optical grating with the incident light projects onto the grating. The thicknesses of ITO, SnO2, and ZEP520A are set at 50 nm, 50 nm, and 350 nm, respectively. Field distribution at the grating with the (b) on-res




(a) Broadband and (b) narrowband spectral reconstruction using the integrated spectrometer. The broadband spectrum is generated by a continuous laser while the narrowband spectra are generated by the PL from QD film with different nanocrystal sizes. Resul

“Exploring the conjugated-BIC is unconventional when compared with those popular BIC lasing studies. Through the theoretical study, we find that the conjugated-BIC experiences high leakage and decent Q while it can be easily excited and coupled. Considering that the conjugated-BIC photonics can be facily fabricated and their resonant wavelengths can be effectively tuned, we anticipate that the conjugated-BIC is very suitable for wavelength-resolved photodetection

applications.”

“Solving the problems in fabricating perovskite photodiode arrays and integrating them with the conjugated-BIC photonics by micro-fabrication processes are also important since the materials and device interfaces of the devices can be easily destroyed during the processes by solvents and heat. We also believe that the photonics-optoelectronics integration platform we proposed can provide insight into broadening the functionalities and applications of the emerging solution-processable semiconductors like perovskites.” the scientists forecast.

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References

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