

# Research Highlights

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## A New On-chip Sensor for Infrared Spectrography

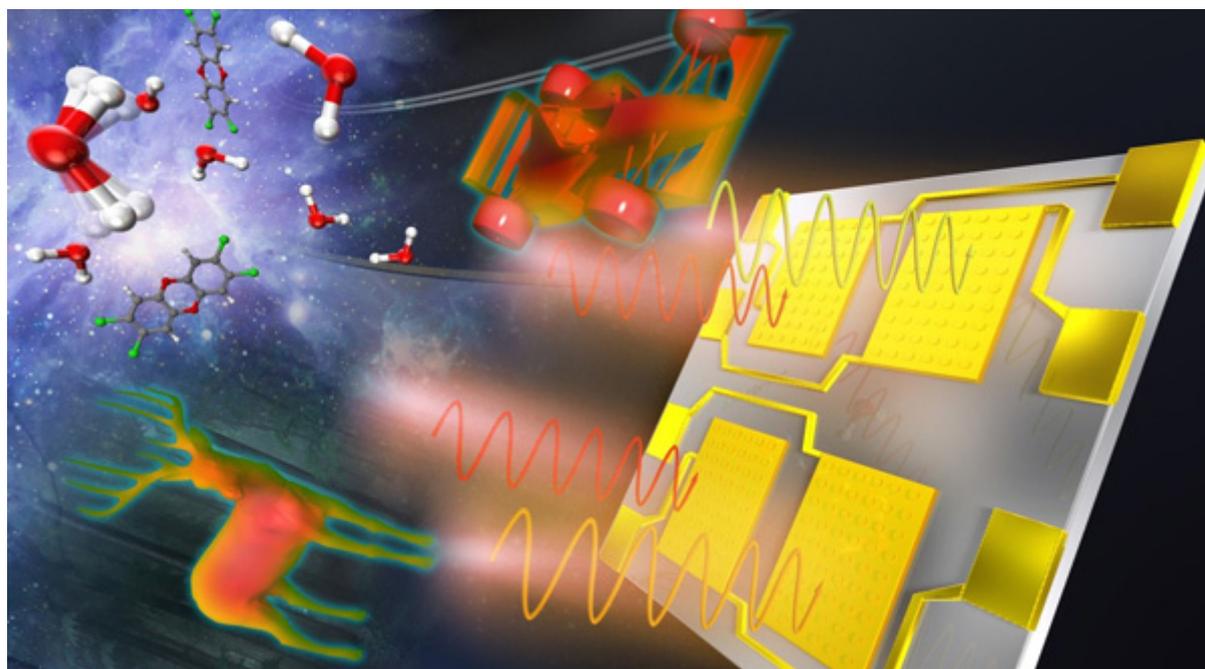
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A team at MANA has created a new type of multi-wavelength infrared sensor capable of detecting thermal radiation of specific wavelengths. It could have a range of applications, including temperature/materials-specific imaging and remote sensing of air pollution.



Infrared spectroscopy is a powerful technique for identifying chemicals by analyzing their vibrational absorptions, as well as for characterizing the optical properties of narrow bandgap semiconductors, quantum-well emitters and thermal absorbers.

Every material has its own characteristic emission spectrum. Gases, for example, have sharp emission lines, and a spectrometer can identify specific types of gas molecules. However, most infrared sensors do not have wavelength resolution and detect the entire integrated intensity, limiting the information that can be derived from a material.

MANA's new sensor boasts an ultra-narrowband resolution and a high directivity, so it can sense gases and measure the temperatures of objects without calibrating their emission intensity and temperature beforehand.

It can detect thermal radiation at a specific wavelength and restrict its incident direction. The team patterned periodic electromagnetic nano-absorbers on a metal surface, so that incident thermal radiation diffracts and propagates parallel to the absorbers' surface. The diffracted wave is hybridized with the surface plasmon polariton on the periodic metal surface and generates heat

signal while it propagates in a very narrow window in angle and wavelength for the incident thermal radiation.

The result is the world's highest-performance such sensor, with a wavelength resolution as high as 50 nm and a directivity better than  $\pm 1$  degree, with multiband infrared sensors mounted on a single chip.

This could lead to a range of new products, including miniature spectroscopic infrared devices for true-temperature pyrometry, gas imaging, position and motion sensing with high angular resolution, materials-specific imaging, and environmental sensing.

This research was carried out by [Tadaaki Nagao](#) (MANA Principal Investigator, Group Leader of Photonics Nano-Engineering Group, MANA, NIMS) and his collaborators.

## Reference

"An On-Chip Quad-Wavelength Pyroelectric Sensor for Spectroscopic Infrared Sensing"  
Thang Duy Dao, [Satoshi Ishii](#), Anh Tung Doan, Yoshiki Wada, Akihiko Ohi, [Tadaaki Nagao](#) and [Toshihide Nabatame](#)  
Journal : Adv. Sci. 6 (2019) 1900579.  
DOI : [10.1002/advs.201900579](https://doi.org/10.1002/advs.201900579)

(Press release on this research)

"A Spectroscopic Infrared Sensor with World-Class Wavelength Resolution"  
[https://www.nims.go.jp/mana/news\\_room/press/2019082601.html](https://www.nims.go.jp/mana/news_room/press/2019082601.html)

(News Article on this research)

"Tadaaki Nagao, MANA Principal Investigator Appeared in Advanced Science News"  
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