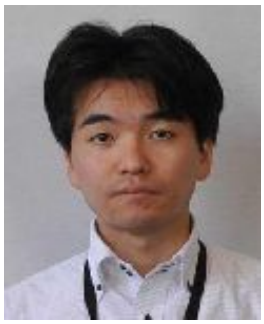
# Development of type II superlattice detector for future space applications at JAXA

Haruyoshi Katayama*[a], Junpei Murooka[a], Masataka Naitoh[a], Tadashi Imai[a], Ryota Sato[a], Eichi Tomita[b], Munetaka Ueno[c], Hiroshi Murakami[c], Satoshi Kawasaki[d], Masafumi Kimata[d], Takahiro Kitada[e], Toshiro Isu[e], Mikhail Patrashin[f], Iwao Hosako[f]

[a] Earth Observation Research Center (EORC), Space Applications Mission Directorate, Japan Aerospace Exploration Agency (JAXA), 2-1-1 Sengen Tsukuba, Ibaraki 305-8505 JAPAN;
[b] Space Applications Program Systems Engineering Office, Space Applications Mission Directorate, Japan Aerospace Exploration Agency (JAXA), 2-1-1 Sengen Tsukuba, Ibaraki 305-8505 JAPAN;
[c] Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA),
3-1-1 Yoshinodai, Chuo-ku, Sagamihara, Kanagawa 252-5210 JAPAN;
[d] Graduate School of Science and Engineering, Ritsumeikan University, 1-1-1 Noji-higashi, Kusatsu, Shiga 525-8577 JAPAN;
[e] Institute of Technology and Science, The University of Tokushima, 2-1 Minamijyousanjima-cho, Tokushima 770-8506 JAPAN;
[f] New Generation Network Center, National Institute of Information and Communications Technology (NICT), 4-2-1 Nukui-Kitamachi Koganei, Tokyo 184-0015 JAPAN;

## BIOGRAPHY

**Haruyoshi Katayama**: The author obtained Ph.D in 2003 at Osaka University, Department of Earth and Space Science. From 2003, he works at Japan Aerospace Exploration Agency (JAXA) as an engineer. From 2006, he is involved in the research and development of earth observation sensors.



## TECHNICAL ABSTRACT

The performance of space-borne infrared detectors is required higher sensitivity, higher resolution, or larger format in comparison with that of ground-based infrared detectors. In order to realize higher mission requirements, JAXA decided to position the infrared detector technology as one of the strategic technologies of JAXA and to promote the development of the infrared detectors.

InAs/GaSb Type II superlattice (T2SL) is the only known IR material that has a theoretically predicted higher performance than HgCdTe. If the T2SL detector is realized, it can be applied for many infrared sensors which are required higher sensitivity such as an imaging Fourier Transform Spectrometer. The final goal of the T2SL detector development is to realize an array detector having a cutoff wavelength of $\lambda c$=15μm.We have started a basic research on the T2SL detector.

Figure 1 (left) shows a design of the T2SL crystal sample we fabricated. We started from the mid-wave infrared (MWIR) T2SL detector having a cutoff wavelength of about 6μm. The T2SL crystal sample is designed for pin diodes with superlattice having thickness of 9 monolayers (ML) InAs and 7 ML GaSb. In order to compensate for the residual compressive strain due to the lattice mismatch between InAs and GaSb, 0.9 ML InSb is grown between InAs layers and GaSb layers.

The samples were grown with solid-source MBE, using a Veeco Gen II system at National Institute of Information and Communications Technology (NICT). After some iterations and fine tunings of MBE parameters, we could obtain a good quality crystal. Figure 1 (right) shows the cross section of the T2SL crystal obtained with TEM.

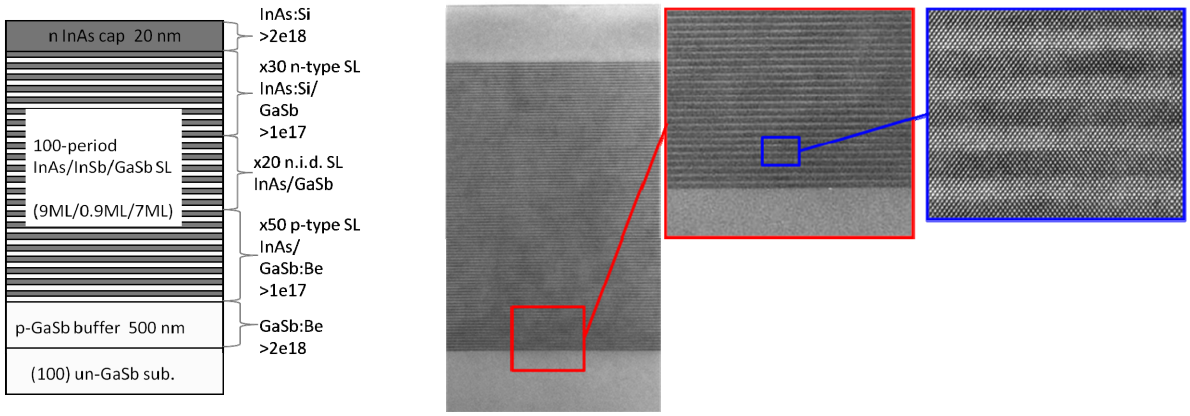



**Figure 1. Design (left) and TEM pictures (right) of the T2SL crystal.**

Figure 2 shows a spectral responsivity of the T2SL single pixel detector measured at 30 K and -20mV bias. The responsivity is about 0.33±0.05A/W at 4.5μm. The quantum efficiency is corresponding to about 9%. The cutoff wavelength (defined as the point where the responsivity drops to 50% of the 4.5 μm value) is 5.5μm. This is near to the designed cutoff wavelength.

In this paper, we introduce the T2SL detector development programs at JAXA. We also show the current status of the T2SL detector development.

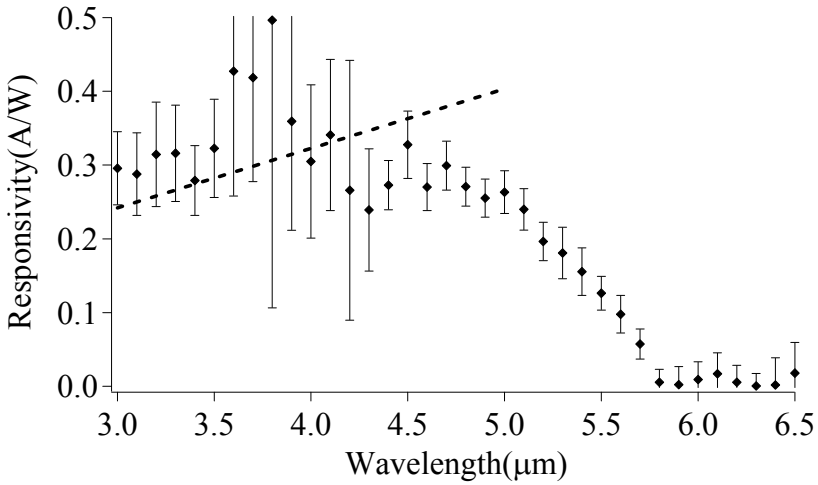



**Figure 2. Spectral responsivity of the T2SL single pixel detector. Dashed line represents the quantum efficiency of 10%.**

**Keywords:** Infrared detectors, InAs/GaSb Type II superlattice, Mid-wave infrared

*katayama.haruyoshi @jaxa.jp; phone +81-50-3362-4806; http://www.jaxa.jp