IRFPA Development in Japan

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BIOGRAPHY

Masafumi Kimata: Masafumi Kimata received the B.S. and M.S. degrees in electronic engineering from Nagoya University in 1974 and 1976, respectively, and received the Ph.D. degree in engineering science from Osaka University in 1992. He joined Mitsubishi Electric Corporation in 1976, where he was involved in research and development of silicon-based infrared focal plane arrays, including Schottky-barrier cooled infrared focal plane arrays and SOI diode uncooled focal plane arrays. In 2004, he retired from Mitsubishi Electric, and presently he is a professor at Ritsumeikan University, where he continues his research on MEMS-based uncooled infrared focal plane arrays and type-II superlattice infrared focal plane arrays. He was awarded the Prime Minister Prize of the Japan National Invention Awards in 1993 for his invention of high-resolution Schottky-barrier infrared focal plane arrays. He is a fellow of SPIE and has been serving as a program committee member of SPIE’s conference on Infrared Technology and Applications since 1992.

TECHNICAL ABSTRACT

Research activities devoted to infrared focal plane arrays (IRFPAs) in Japan have been limited due to the country’s domestic business environment, and they are very different from those in other countries. This presentation reviews the history and current state of IRFPA development in Japan.

Development of HgCdTe IRFPAs was active in Japan from the beginning of the 1990s to the mid-2000s. Not only liquid phase epitaxy (LPE) technology but also molecular beam epitaxy (MBE) and metalorganic chemical vapor deposition (MOCVD) technologies on alternative substrates, such as GaAs and Si, were investigated for large-format IRFPAs. A 640×480-element IRFPA for the MWIR band and 256×256-element IRFPAs for the LWIR band were developed by the mid-2000s1).

In parallel with the development of HgCdTe IRFPAs, considerable efforts were made to develop high-resolution PtSi Schottky-barrier IRFPAs. Japan played the leading role in this area and reported a 512×512-element IRFPA in 1987 and a 1040×1040 IRFPA in 19912). From the late 1980s, many infrared cameras were commercialized with the PtSi Schottky-barrier technology. Two space-borne PtSi Schottky-barrier linear FPA, with structures of 4096 elements ×4 bands and 2100 elements × 6 bands, were also developed for Japan Earth Resources Satellite-1 and Earth Observing System-AM1, respectively.

Despite the vigorous efforts of the companies involved in cooled IRFPA development, the domestic infrared market in Japan did not grow as they expected, and development of cooled IRFPAs became inactive by the mid-2000s.

However, the Japan Aerospace Exploration Agency (JAXA) has recently acknowledged that Japan needs its own cooled IRFPA technology to achieve future missions, and thus it initiated a project to develop type-II superlattice IRFPAs in collaboration with the National Institute of Information and Communications

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Technology (NICT) and Ritsumeikan and Tokushima Universities\textsuperscript{3}). This project is expected to reactivate R&D in the Japanese sector of the cooled IRFPA industry.

In the arena of uncooled IRFPA technology, Japan is rapidly catching up with the most advanced American and European companies. The uncooled IRFPAs being developed in Japan are based on the VO\textsubscript{x} microbolometer and SOI diode technologies. Both have reached the level where VGA-format IRFPAs with 25-\mu m-scale pixels are being commercialized. More advanced technologies for 17-\mu m pixels and beyond were reported last year\textsuperscript{4}, \textsuperscript{5}). Mitsubishi Electric has already developed a 15-\mu m-pixel uncooled IRFPA, adopting a 2M SOI diode, in collaboration with JAXA\textsuperscript{6}).

In contrast with the United States and Europe, small-format IR array sensors are becoming a noteworthy trend in Japan. At the CEATEC 2010 exhibition, three companies demonstrated thermopile small-format IR array sensors with 8×8 to 16×16 pixels and human-detection systems with array sensors. Several other Japanese companies are also working on the same class of IR array sensors. The application targets for these small-format IR array sensors seem to be such consumer electronics as air conditioners. Technologies are also being developed to support the commercialization of uncooled IRFPAs and small-format IR array sensors. Chip-scale vacuum packaging\textsuperscript{7)} and the development of versatile vacuum packaging equipment\textsuperscript{8)} are examples of such supporting technology being developed in Japan.

**Keywords:** Infrared focal plane array, HgCdTe, PtSi Schottky-barrier, uncooled infrared detector, microbolometer, SOI diode, thermopile

**References**