Introduction to Special Issue on Advanced Terahertz Technologies and Efforts Toward Practical Applications

IN NEWSPAPERS and TV reports these days, many readers may have found the word "terahertz" not once but many times. In webpages, we find its definition as one of the units in SI (Systèm International d'Unités) referring to a frequency band that presents both light-like free-space propagation and high penetration more characteristic of lower-frequency electromagnetic wave. Even if one is working outside of the field, he/she might be caught by the expectation for some significant science and technical breakthroughs after hearing the above characteristics.

Early interest in terahertz waves in Japan stimulated the compilation release of a special issue in the *Journal of the IEICE* (Institute of Electronics, Information and Communications Engineers). This special issue appeared in June 2006 under the title: "Terahertz-wave Technology: Breakthroughs brought about by as-yet-undeveloped electromagnetic wave." The special release presented papers detailing state-of-the-art technologies in terahertz science and proposing applications that would inspire readers to look towards this field of development for future breakthroughs. Almost 10 years have passed since then. The technology has made great strides towards practical applications, and has even triggered some social applications in a few areas. The terahertz era has come!

The present IEICE special issue "Terahertz technology: Advances and development for practical applications" presents the latest approaches and progress in the terahertz field from fundamentals to applications development . In particular, it focuses on the efforts to realize practical applications that will help us move forward towards a terahertz technology age.

The special issue is grouped into three areas, namely, Introduction, Elementary technologies and Application developments.

Part 1, "Introduction," presents an overview of terahertz as well as major strengths and limitations so that non-specialists can understand the basics and the background.[1]

Part 2, "Elementary technologies," describes two elementary components, sources and detectors, and two basic instrumentation techniques, spectroscopy and imaging. The article on sources focuses on high-power continuous terahertz-wave generation based on nonlinear optical wavelength conversion. The detector technology article discusses plasmon detectors and other commonly employed devices. The imaging article reviews various pulse-based imaging principles and techniques. All the articles try to include the latest techniques and results and to reach a wide audience.[2]

Part 3, "Application developments," presents new trends in the realization of practical applications in eight areas. They describe developments and standardization of domestic/global terahertz wireless communications, terahertz observations of the cosmos using satellites in space, new medical techniques for diagnosis of diseases such as breast cancer and burn injury, and non-marker detection techniques for biomedical agents. Other topics include astronomical-body and atmospheric observation techniques using superconductive receivers, and commercially available terahertz spectrometers for non-destructive inspection.[3]

Active terahertz investigations are not limited to the above fields, but also include foundational research in semiconductor device technology as well as many other fields that impact our daily lives, that is, our health, safety and security.

The Guest Editors express their sincere appreciation to the authors contributing to this IEICE Special Issue. They also deeply thank the dedicated associate editors including the members of IEICE Technical Group on Terahertz Application Systems, namely, Masaaki Maezawa, Atsushi Imai, Masayuki Odo, Takahide Oya, Takaharu Oyama, Kenji Shiojima, Shintaro Shinjo, Satoshi Sugahara, Yasushi Shinjo, Michiko Harumoto, Kunihiko Fujita, Hiroyuki Hosono, Kenichi Maruhashi, Taro Yamashita, and Minoru Watanabe.

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[1]This Introduction by T. Nagatsuma is available in the original Japanese special issue for non-specialists in terahertz science and tethnology, but has not been included in this compilation of translated papers.

[2]The article "Terahertz spectroscopic systems based on Terahertz time-domain spectroscopy" by K. Kitagishi is available in the original Japanese special issue, but has not been included in this compilation of translated papers.

[3]The article "Security and Safety Applications" by T. Otani is also available only in the original Japanese special issue, but not in this compilation of translated papers.

Introduction to the English Translation

This mini-special issue is a translation of Special Issue on "Advanced Terahertz Technologies and Efforts Toward Practical Applications" published in *The Journal of IEICE* in November 2014 [1] with the above Introduction. Among the articles in the original special issue, three papers are not included here, as indicated in the footnotes, and the article grouping is not shown here explicitly. However, the coordinators believe this issue will have a high impact on the terahertz fields widely

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References

[1] "Special issue on advanced terahertz technologies and efforts toward practical applications," *J. IEICE*, vol. 97, no. 11, pp. 917–1005, Nov. 2014.

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