Commission D (Electronics and Photonics) Activity Report

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1) Commission Activities

AP-RASC2010:

Follwings are summary reports by conveners who were responsible for technical sessions related to Commission D (all sessions were held on October 25 and 26, 2010).

D1: Advanced electronic devices and circuits for ubiquitous wireless (Prof. Kado and Prof. Fujishima)

This session includes three invited and three contributed papers. All the invited papers are on devices and circuit technologies for wide-area ubiquitous networks developed at NTT Laboratories; Dr. Harada described extremely low-power wireless terminals, which cover 5-km radius with 10-mW output power ensuring 10-year battery life. For this 10-year battery life, Dr. Ugajin presented their work on low-leak regulator circuits for intermittent LSI operation. Dr. Oshima described in particular highly efficient power amplifiers by introducing a new method of reducing signal distortion for low-power consumption. As a contributed paper, Prof. Higashino of Osaka University proposed a new zone multiplexing scheme to radio-on-leaky-coaxial cable (LCX) system in order to suppress the interference effect among the wireless service zone. Dr. Izumi of Kobe University presented a very low-power LSI processor dedicated to be used in each node of wireless sensor networks with an average power consumption as low as 58 μW. Final contributed paper was given by Dr. Abe of Tokushima University on the effect of the Si-substrate conductivity in the application of wireless interconnections between Si-LSIs and AlGaN/GaN HFETs on sapphire substrate.

D2: Trends in electronic/photonic devices and circuits (Prof. Umeda and Prof. Fukushima)

This session includes four invited papers and one contributed paper. Three papers are related to electronic devices and circuits, whereas two papers are related to photonic ones. Prof. T. Waho presented his recent research activities on delta-sigma (ΔΣ) analog-to-digital converters (ADC) for wireless communications. Increase in frequency of the input radio signal is achieved by employing the bandpass ΔΣ architecture that can decrease a sampling rate of a ΔΣ ADC. In addition, the continuous-time ΔΣ architecture much increases the operating speed by replacing the switched capacitor discrete-time filter with a continuous-time filter. Prof. K. Maezawa and his colleagues presented high-speed circuits based on resonant tunneling diodes (RTDs) and their application to analog-to-digital converters. Proposed monostable-bistable

transition logic element (MOBILE) can be applied to a high-speed D-flip-flop (DFF). The frequency-modulation (FM) ΔΣ modulator using MOBILE as a quantizer is suitable for high-frequency operation because it does not have feedbacks. A 100-GHz oscillator using RTDs is also demonstrated. Prof. H. Amano presented recent trends on dynamically reconfigurable processors (DRPs). Recent trends on DRPs are (1) small sized PE array specialized for a certain application and (2) multi-core structure using multiple small sized processing element (PE) arrays. A prototype chip of a DRP with three-dimensional wireless interconnect named MuCCRA-Cube is also reported. It can increase the number of PE arrays by using the inductive coupling technique. Prof. W.-Y. Choi presented his recent research results of a CMOS-compatible APD and its integration with a trans-impedance amplifier (TIA). Unlike conventional APDs, the reported APD is fully compatible with the CMOS process. In his talk, the receiver integrated with the APD and TIA was presented and a 4.25-Gb/s reception was demonstrated experimentally. Dr. I. Ogawa and his colleagues have engaged research and development of PLC and LN modulator integration for multi-level optical modulators/demodulators. With their excellent techniques, they have successfully developed many kinds of modulators employing multiplexing technologies such as OFDM and PDM.

DC1: Meta-materials and their applications (Prof. Sanada and Prof. Sano)

In DC1-1, invited speaker, Prof. Kitano, presented no-reflection, no-refraction metamaterial for circularly polarized light. He suggested that by introducing a chirality parameter, novel and useful EM phenomena can be observed. In DC1-2, invited speaker, Prof. Sanada, presented the wave propagation in a medium with a single negative component in the permittivity/permeability tensors investigated both numerically and experimentally. He demonstrated the advantage of an anisotropic structure over double-negative or left-handed materials. In DC1-4, Okubo and Tsutsumi described the propagation characteristics of left-handed ferrite waveguides with air gap using the high frequency structure simulator (HFSS) taking up effect on wide variety of ferrite periodic structures, and their characteristics are confirmed by experiments. In DC1-5, Takahagi and Sano proposed a method for improving the gain of a Si on-chip antenna using an artificial dielectric layer (ADL) inserted between the antenna and Si substrate. Design and experimental results were described. In DC1-6, Belousov et al. showed that by tuning the parameters of a photonic crystal layer, one can suppress certain emission lines of dyes, subsequently increasing the change of the fluorescence spectra of the sensing layer in the presence of analyte. In DC1-7, Wakatsuchi et al. discussed the contribution of conductive losses to the overall absorptance of a cut-wire metamaterial and revealed that materials with suitable conductive losses are becoming readily available through recently developed technologies, e.g. conductive inks. In DP-1, Kamenetskii discuss a problem of realization of magnetoelectric (ME) particles and ME metamaterials. In DP-2, Qi et al.

presented a Fabry-P´erot-like(FP-like) formalism for the transmittance spectrum characteristics of a subwavelength single slit in a metallic film.

DC2: Microwave photonics technology (Prof. Toda and Prof. Nirmalathas)

This session included four invited papers and two contributed papers related on microwave photonics technology. In DC2-1, invited speaker Dr. F. L. Hong, AIST Japan, presented applications of optical frequency combs for frequency standards. In DC2-2, invited speaker Mr. P. T. Dat, Waseda University Japan, presented their recent experiments on transmission of W-CDMA signal with radio over free space optical network. In DC2-3, Prof. K. Kumamoto, Osaka Institute of Technology Japan, presented convergence of broadcasting and communication utilizing CATV network. WiMAX and W-LAN signals were transmitted over 35 km using radio-over-fiber technique with installed optical CATV infrastructure. In DC2-4, invited speaker Prof. C. Lim, The University of Melbourne, Australia, presented high performance radio-over-fiber links. Digitized wireless optical signal transport is used to overcome the inherent issues associated with analog optical link. In DC2-5, invited speaker Dr. T. Kuri, NICT Japan, presented reconfigurable DWDM mm-wave-band radio-over-fiber networks for wireless and wired signal convergence. In DC2-6, Mr. D. Takeuchi, Meijo University Japan, presented phase and amplitude control of optically controlled phased array antenna. Using commercially available optical telecommunication components, beam steering of 3-GHz microwave signal was performed.

DC3: Terahertz-wave technology (Prof. Otsuji and Dr. T. Kleine-Ostmann)

This session devoted to discuss about state-of-the-art of terahertz-wave technology in a broader area from millimeter waves to far infrared waves. The session accommodated five invited papers authored by world-leading researchers in terms of novel/innovative devices, components, as well as application systems for security/safety sensing/imaging and future broadband wireless communications. Prof. H. Ito at Kitasato University presented photomixer-type terahertz source device technology based on his group's original uni-travelling-carrier photodiodes (well known as UTC-PD's). More than 10-μW power at 1.04 THz could be produced with a resonant-type integrated antenna. Prof. V. Ryzhii at University of Aizu presented his original idea for new graphene-based terahertz photonic devices including new type of lasers, mid-infrared phototransistors. Due to its extraordinary carrier transport properties in the gapless, linear band structure graphene will become an epoch maker to bridge over the "terahertz gap." Prof. P. Uhd. Jepsen at Technical University of Denmark presented novel polymer microstructured fibers for guiding of terahertz radiation. Thanks to the photonic-crystal-fiber design, various types of structures/polymer-materials are demonstrated. Using terahertz time-domain spectroscopy important properties like losses, dispersions have been successfully characterized. Future trend

was also directed. Dr. C. Otani at RIKEN presented two topics on terahertz sensing for safety and security, one for inspection of illicit drugs in mails and the other for terahertz beam steering. He introduced his original smart screening system for inspecting illicit drugs and hazardous substances in mail envelopes, incorporating first-stage rapid screening part using X-ray imaging and the second-stage accurate identifying part using terahertz scattering. Prof. T. Nagatsuma at Osaka University presented 100-400 GHz band wireless communications technology. In the last decade he and his former group in NTT have been taking advantage of the millimeter wave communication at 120 GHz and beyond. Now the level comes up at 300 to 400 GHz carrier frequencies at Gbit/s level. Electron devices do not work in such a high frequency range so that they utilize a smart way of photonic carrier signal generation/modulation. Future direction to the terahertz wireless communication was also addressed. In spite of the final date of the conference, the session room was filled with large number of audiences. This is a proof that this emerging area and research topic have attracted attention very much. Related to this DC3 session field two excellent contributed works were accepted as poster presentation. Dr. T. Kleine-Ostmann at PTB, Germany demonstrated their original millimeter-wave communication utilizing commercially available hardware implementation. Prof. I. Khmyrova at University of Aizu presented a novel device modeling for terahertz plasmon-resonant dual-grating gate transistors.

2) **Domestic Activities Related to Areas Covered by Commission D**

IECIE Society Conference (at Osaka Prefecture University, 14 September):

Session C-14 (Microwave Photonics) included 15 contributed papers on optically controlled phased array and beam forming, combination of radio-on-fiber and MIMO, fusion of communication and broadcasting services for digitally divided areas, optical modulation of 60-GHz signals in InP-HEMTs, stabilization of lithium-niobate electric-field sensor, accurate EO sensing by homodyne detection, high-power RF photodetectors, calibration scheme for photodetectors using optical modulators, ultra-wideband (UWB) signal generation using FBGs, 14-Gbps transmission using 300 GHz wireless link, efficient generation of in-coherent THz signals, high-speed THz spectroscopic imaging using Schottky- barrier diodes. Session CS-8, which is a symposium on perspective of devices and systems for over 100 GHz and 100 Gbit/s, included 6 invited talks on over-100-GHz InP-based HEMT ICs, high-speed multi-media transmission systems based on hybrid optical CDM and TDM, trends in ultrafast optical signal processing devices, CMOS IC technology for THz region, overview and future of THz technology, generation of THz signals and their applications.