2017-IM-J-Tokyo-Tech-EEIC-Engrg.

IWAMOTO Mitsumasa

"Development of Evaluation Method for Organic Molecular Materials Electronics"

1. Biography 1952-1-21 Birth　Nagano

1975 Tokyo Institute of Technology, B.E

1981 Tokyo Institute of Technology, Dr.Eng.

1981 Tokyo Institute of Technology, Academic Staff・Research Associate (1982)

1986 Tokyo Institute of Technology , Associate Professor.

1995-2017 Tokyo Institute of Technology, Professor (2017 Professor Emeritus of Tokyo Institute of Technology)

2017-2022 Specially Appointed Professor (Tokyo Tech-Tsinghua Joint Program Professor, Visiting Professor of Tsinghua University),

Others: Visiting Professor of China Academy of Science (2017-2020)， Academic Icon Professor of University of Malaya (2013-16), External examiner of University of Malaya (2010-13, 2017-), Visiting Professor of UCSI, Malaysia（2021- ）

2.Awards（representative）：

Best Paper Award (Institute of Electrical Engineers of Japan, 1985), Yamazaki Award, (The Society of Materials Engineering for Resources of Japan, 1990), JSAP Award A (The Japan Society of Applied Physics, 1991), Electronics Society Award (The Institute of Electronics, Information and Communication Engineers, 2001), Fellow of JSAP (2010), Fellow of IEICE (2010), M&BE Achievement Award, (JSAP, 2015), Fellow of IEE of Japan (2019), Ieda Award (IEE of Japan 2019), Distinguished Member of JSAP , 2021)

3. Summary：

Electrical phenomena in electrical insulating materials are very complex. Iwamoto proposed a new numerical calculation method based on ionic hopping model, and established a way for analyzing carrier behaviors in electrical insulating materials. Based on successful achievement of this study, he jumped in most advanced research field bridging molecules and electronics (Organic Molecular Electronics) that emerged in USA in the year of 70's, where he made a great contribution as a pioneer for development of evaluation method of organic electronic materials in the field of organic molecular materials electronics. Among them are evaluation method of organic thin films, detection of specific electronic phenomena of molecular films and its application to electronics, and others. He always found conceptional ideas of his research projects in the field of dielectrics and electrical insulation engineering, and conducted many pioneering works.

4. Achievement of Research and Impact to Societies

For understanding of dielectric properties of organic films, it is essential to study dielectric polarization. For organic materials and molecular electronics application, development of preparation method of molecular thin films, evaluation method of carrier transfer and charging, trapping etc. in molecular films are important. Iwamoto proposed electrical method named Maxwell Displacement Current measurement (MDC) that can evaluate rotational motion of dipoles in organic monolayers [1], evaluation method of the nano-structure interfaces of organic thin films[2], visualization method of electron transfer in orgic thin films and in organic devices by using electric field-induced optical second harmonic generation (EFI-SHG) [3], analytical method of organic electronic devices as Maxwell-Wagner effect elements [4], analytical method of electrostatic phenomena of ultra-thin polyimide thin films, and preparation and detection of electron tunneling devices using polyimide thin films [5]. These were pioneering works in the early stage of organic materials electronics [6,7].

4.1. Analysis of carrier transport in insulating films by Hopping method.

He proposed a numerical method based on ion hopping model [8], and showed that many complex carrier behaviors in electrical insulators can be analyzed with consideration space charge effects that are caused from interface charges, trapped charges and so on.

4.2. Maxwell-displacement current of organic monolayers on water surface and detection of molecular switching.

He proposed an experimental method for determining dipole moment of molecules in monolayers on water-air interface [1], and successfully detected molecular switching due to cis-trans photoisomerization of molecules in monolayers, phase transition of monolayers [9], etc. The proposed method was the pioneering work in the world, and he constructed an MDC experimental system and firstly detected the generation of Maxwell-displacement current due to rotational motion of organic molecules in monolayers.

MDC system for organic monolayers

4.3. Polar structure and dielectric property of interfacemolecular films

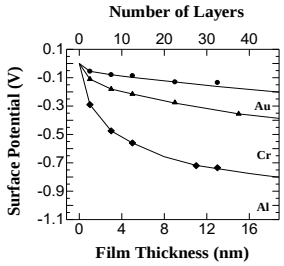
For characterizing organic polar structure of organic monolayers, he proposed an idea using orientational order parameters, i.e., S_1, S_2 and S_3, and developed an experimental system that can probe and visualize liner polarization and nonlinear polarization of organic monolayers. The developed experimental system were comprised of MDC system that can probe S_1 by the detection of spontaneous polarization, BAM (Brewster Angle Microscope) system that can probe S_2 and visualize linear polarization of monolayers, and SHG system that can probe S_1 and S_3 and visualize nonlinear polarization of monolayers. He showed a way for analyzing polar structure of monolayers using order parameters [2,11].

4.4. Analysis of Shape deformation of domains on water surface and the effect of Maxwell electrostatic effect.

Using the experimental system described in 4.3, he visualized domains in monolayers on water surface and revealed the polarization structure. In particular, he showed the presence of quantized domain shape structures, i.e., circular and clover leaf shapes, *m*-sided domains (*m* =1, 2, 3,…), etc. Starting from the free energy of domains in monolayers, he derived shape equations for analyzing domain shapes using *differential geometry* in mathematics for the first time, and revealed that the electrostatic dipolar energy is converted to a negative line tension and a curvature-elastic energy, and leading to a variety of intriguing domain shapes [12]. The original source of domain deformation is shown to be related to Maxwell-electrostatic stress [13].

4.5. Electron tunneling across ultrathin polyimide film and nano-electro statistics

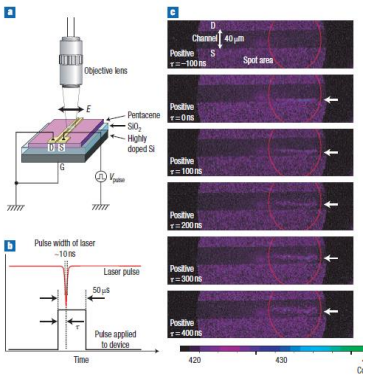
He proposed a preparation method of ultrathin polyimide (PI) thin film (0.4 nm/monolayer) by using Langmuir-Blodgett technique, and successfully showed that PI thin film work as a tunneling spacer of Josephson junctions [5,14]. He also showed a single tunneling behavior of ultrathin PI film by introducing functional molecules. Also, by using Kelvin probe surface potential method, he determined spatially and energetically the distribution of nano-electrostatic charging at metal-ultrathin film interfaces [15], and proposed a way for analyzing and modelling nano-interfaces caused by electrostatic charging [16].



Surface potential of PI LB films on metals [15]

4.6. Visualization of carrier transfer in organic thin films

He for the first time proposed a way for probing and visualizing carrier transfer in organic thin films by using electric-field optical second harmonic generation (EFISHG). The method was based on the idea that nonlinear polarization caused by coupling of electric-field of incident-laser beam with d.c. electric-field from electrons in organic thin films can be probed as EFISHG [17] Using the developed experimental system, he probed and modelled the carrier transfer in organic field effect transistors, organic solar cells. Organic electro light emitting diodes, etc. [3,17]. Also, the electric field distribution in devices have been analyzed and visualized by the EFISHG.



Visualized carrier transfer in Organic

4.7. Electric field distribution and I-V characteristics of organic devices

He proposed an idea of using Maxwell-Wagner model for analyzing organic devices such as organic field effect transistors, organic EL devices, organic diodes, etc. [4]. Also he developed a system for evaluating

life-time of organic solar cells by using EFISHG, and also showed a way for analyzing TENG (tribo-electric nano generator) (Book (2)).

5. Activities in Societies (representative):

JSAP Executive Director (2007,2008), JSAP Director (2009-2011), JSAP M&BE Executive Director (2005, 2006), IEICE Chair of Organic Molecular electronics（1993－1995), IEICE Advisory of Organic Molecular electronics（2001－), IEEJ Board Member(Fundamental and Materials Society) (2001－2003）, ibid, chair of Investigating R&D Committee（1993－2016 others), Cabinet Office, Evaluation Committee member of Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST)（2012,2013), ibid, evaluation subcommittee chair (2014), Industrial Standards Committee member, Ministry of Economy, Trade and Industry, JAPAN (2011-20), Committee member (2018-21) chair of committee 2022-）of The Japanese Standards Association (JSA), Program officer of the Japan Society for the Promotion of Science (2013- 2016), etc. Char of International conference (ICNME 7 times, M&BE 1time, IDCNICE 7 times), Editorial member of Association of Asia Pacific Physical Societies (AAPPS) (2011-2014), advisory board member of AAPPS (2014-2017), Gust editors of international journals (Thin Solid Films 7 times, Jpn. J. Appl. Phys 1time) and domestic journals (IEE of Japan, and IEICE), etc.

6. Others: Iwamoto was a pioneer in the field of "organic electronics" in Japan, which emerged in the end of 20th century, and made a significant contribution to research and education in this field. He conducted many international cooperative works, and many scientists and PDs from overseas stayed in his laboratory. 26 doctor course students were awarded doctor degrees under supervision of him. He also made a great contribution for the establishment of joint graduate course program between Tokyo Tech and Tsinghua University, China (the joint graduate course program was the first one in Japan.). Also he has been serving for long time as a committee member (from 2002) or a committee chair (from 2016) of JSEC (Japan Science and engineering Challenge) for encouragement of students in the secondary education (http://manabu.asahi.com/jsec/), and also serving as a chief of committee of ethics for the secondary education of APRIN (from 2016) (APRIN) https://www.aprin.or.jp/e-learning/rse.

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BOOKS (representative)

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