【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)

Title of Project : Analysis of carrier transport and polarization in organic films as dielectric phenomena by using MDC and SHG, and its application to organic device characterization

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Research Area : Engineering

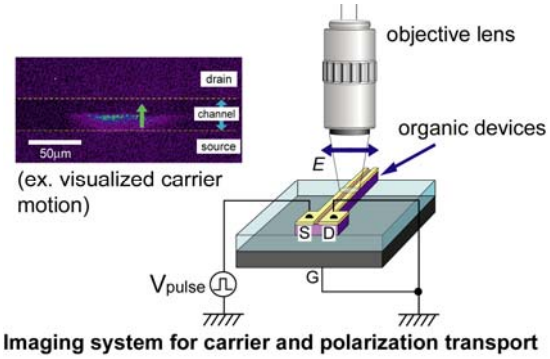
Keyword : Electrical and electronic materials, Dielectric, Organic/Molecular electronics

【Purpose and Background of the Research】

On the basis of deep understanding of organic material physics concerning flexibility, molecular shape, ordering and alignment of dipoles etc., development of organic device physics and related engineering, leading to a new research field, are highly anticipated in electronics. In this project, by using both Maxwell displacement current (MDC) measurement that allows dynamical dipolar motion to be probed and electric field induced second harmonic generation (EFISHG) measurement that can visualize nonlinear polarization and carrier motion, a method for analyzing dipolar structure in organic materials as well as carrier transport in organic devices is investigated. The goal of this project is to establish a new way to analyze organic device elements, by viewing electronic phenomena caused by electrons and dipoles, in terms of dielectric polarization phenomena.

【Research Methods】

The basic strategy of this project is to focus on static and dynamical dielectric polarization induced in organic materials due to the presence of mobile electrons, dipoles and quadrupoles. Paying attention to the induced nonlinear polarization in the presence of mobile electrons, chiral dipolar polarization by quadrupoles, and spontaneous polarization due to the alignment of dipoles, an experimental system based on MDC and EFISHG measurements is constructed and experimental results will be demonstrated. Based on the results, we study following four topics: (1) Characterization of flexibility of nano-molecular dipolar films by using MDC-SHG measurements, and control of quantized domain shape caused by Maxwell-stress. (2) Visualization and analysis of dynamical carrier motion in active organic device elements with a three-electrode system. (3) Study of carrier dynamics in multilayer system sandwiched in a two-electrode system, and analyses of degradation process and carrier transport leading to recombination and electroluminescence. (4) Piezoelectric property and characterization of organic device element based on quantized molecular shape effect.



Imaging system for carrier and polarization transport

【Expected Research Achievements and Scientific Significance】

A new method to analyze organic device elements will be established, by viewing carrier transport and dipolar motion as dielectric polarization phenomena. Results of this project will be available for analyzing organic FET, organic EL and other organic devices, and will find wide application in the field of organic electronics, including nano-, micro- and macro-devices.

【Publications Relevant to the Project】

- M. Iwamoto, C. X. Wu, "The Physical Properties of Organic Monolayers, "World Scientific, Singapore, 2001.
- M. Iwamoto, T. Manaka, T. Yamamoto, E. Lim, "Probing motion of electric dipoles and carriers in organic monolayers by Maxwell Displacement Current and optical second harmonic generation", ***Thin Solid Films***, Vol. 517, pp. 1312-1316 (2008).
- T. Manaka, E. Lim, R. Tamura, M. Iwamoto, "Direct imaging of carrier motion in organic transistors by optical second-harmonic generation", ***Nature Photon.***, Vol. 1, pp. 581-584 (2007).

【Term of Project】 FY2010-2014
【Budget Allocation】 151,200 Thousand Yen

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