PROBING AND MODELING OF VISULIZED CARRIER MOTION IN ORGANIC FILMS BY OPTICAL SECOND HARMONIC GENERATION

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Probing and modeling of dynamical motions of electrons and dipoles in organic materials is a fundamental research subject in science and electronics. According to the Maxwell's electromagnetic field theory, electrons and dipoles are source of electric field, and materials surrounding electrons and dipoles are thus polarized. By probing dielectric polarization induced by dipoles and electrons, we can visualize and model carrier motion in organic materials. Maxwell's displacement current (MDC) method allows directly to probe orientational dipolar motion in monolayes, e.g., Langmuir-monolayer, where charge induced on suspended electrode, connected to an ammeter in a closed circuit, is monitored as a Maxwell-current during dipoles are changing their orientation. On the other hand a novel optical method based on electric field induced optical second harmonic generation (SHG) is available for directly probing the dynamical electron (and hole) transport as the migration of electric field, where nonlinear polarization induced in materials originating from moving carriers is visualized. In this symposium, firstly basic concept for probing dynamical carrier motions, i.e., electrons and dipoles, by using dielectric polarization phenomena is discussed. Then some of experimental results are shown, and carrier motion is modeled based on our experimental findings: For dynamical carrier motion of electrons and holes, experiments making use of time-resolved SHG (TRM-SHG) technique reveals dynamic changes of SHG intensity profiles, e.g., arising from pentacene, and visualizes the diffusion-like carrier transport in organic field effect transistor (OFET). Results show that carrier transfer in OFET is regulated by the interface charging propagation. Calculation using drift-diffusion equation well accounts for the probed carrier motion by TRM-SHG. This SHG experiments are also employed for probing carrier motion in Organic light-emitting diodes (OLEDs), and finally show that OFET and OLED are analyzed as a system of Maxwell-Wagner effect element. For dynamical orientational motion of dipoles, MDC experiments are employed and BAM images visualize two-dimensional patterns caused by storage of dipolar energy. The results are analyzed using deribed shape equation.

Finally, we conclude that experiments and analysis based on dielectrics physics is a very effective way for analyzing carrier behaviors in organic monolayers as well as in organic thin film devices.

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