Bipolar polarization-sensitive surface photocurrent pulses in the Ag/Pd nanocomposite

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1. Introduction

It is known that photon drag effect [1] (PDE) and surface photogalvanic effect [2] (SPGE) currents have a unique polarization and incidence angle dependencies. PDE and SPGE can be observed in centrosymmetric media. PDE photocurrent originates from the transfer of the photon momentum to a free charge carrier, while SPGE photocurrent is due to diffuse scattering of the photoexcited carriers in the subsurface layer. However, despite the different underlying physical mechanisms, these photocurrents have almost indistinguishable dependencies on the polarization and the angle of laser beam incidence.

In this work, we observed bipolar photocurrent pulses that results from a competition between PDE and SPGE in the film consisting of metal (Ag-Pd) and semiconductor (PdO) nanocrystallites.

2. Experimental and results

The Ag/Pd samples [3] were fabricated by using the thick-film technology, which is conventionally used to produce hybrid integrated circuits and other electronic devices. The fabricated films have a size of 20×20 mm^2 and thickness of 20 μm. To measure the photocurrent the sample was provided with two parallel film electrodes, which were arranged along the opposite sides of the film between the dielectric substrate and the Ag/Pd film.

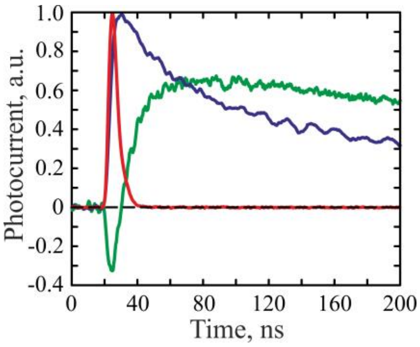

Fig. 1. Oscillograms of the photocurrent pulses induced by *s*-polarized (blue line) and the *p*-polarized (green line) laser beam. Red line shows temporal profile of the excitation laser pulse at 2000 nm.

We measured photocurrent in the Ag/Pd nanocomposite in the spectral range of 1064 – 4000 nm by using a *Q*-switched single-mode Nd^{3+}:YAG laser (repetition rate 1Hz, pulse duration at half-height 19 ns) and optical parametric generator (pulse duration at half-height varied from 6 to 8 ns). The temporal profile of the laser pulses was revealed by the high-speed photodetectors and broadband oscilloscope. The photocurrent was excited by the laser beam passed through a half-wave plate. Rotating the half-wave plate, we controlled the polarization azimuth of the incident beam.

By preforming measurements in the whole wavelength range of 1064 – 4000 nm we found that the *s*-polarized excitation beam produces unipolar photocurrent pulse, which shape is virtually independent of the wavelength (see Fig. 1). In contrast, the temporal profile of the photocurrent produced by the *p*-polarized laser beam essentially depends on the pump wavelength. Specifically, if the excitation wavelength is shorter than 1670 nm, the photocurrent is a unipolar pulse, which lasts longer than that produced by the *s*-polarized beam. However, at the excitation wavelength of 1670 nm, a negative pulse emerges at the leading edge of the positive longitudinal photocurrent. One can observe from Fig. 1 that at a wavelength of 2000 nm, the longitudinal photocurrent is transformed into a distinct bipolar pulse with a sharp negative front and a long positive tail. This is because of the simultaneous generation of the PDE and SPGE photocurrents, which have opposite polarities and different durations as well as different rise and fall times. A large number of photocurrent generation features are presented in the report.

3. Conclusion

Thus we demonstrate that the measurement of photoexcited currents in Ag/Pd nanocomposite allows us to visualize the interplay of the SPGE and PDE. This experimental finding provides a potential to visualize the excitation wavelength without using a spectrum analyzer, i.e. by non-optical means.

3. Acknowledgement

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4. References

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