Influence of electrochemical hydrogenation on the surface photocurrent in the Ag/Pd nanocomposite

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1. Introduction

Light-induced surface currents have attracted a considerable attention recently [1]. In our studies [2, 3] we have shown that Ag/Pd nanocomposite films are able to generate photon drag effect surface current. This allows one to employ this material, which is widely used in electronics, for visualizing polarization of powerful laser beams and/or spatial orientation of the Ag/Pd film with respect to the incident laser beam of an arbitrary wavelength. However in the Ag/Pd nanocomposite the photocurrent pulse duration is substantially longer than the duration of exciting laser pulses. That can be due to the presence of Shotky barriers, which are formed by PdO and Ag-Pd solid solution, in the film [4]. It is possible to remove these barriers with the electrochemical hydrogenation.

The aim of this work is the study of electrochemical hydrogenation influence on the temporal profile of the surface photocurrent pulses in the Ag/Pd nanocomposite.

2. Experimental and results

Ag/Pd nanocomposite films were produced in accordance with thick film technology based on burning of a special paste on a ceramic substrate. The size of the film obtained was 12.5×11 mm, while its thickness was about ~10 μm. To measure the photocurrent the film 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.

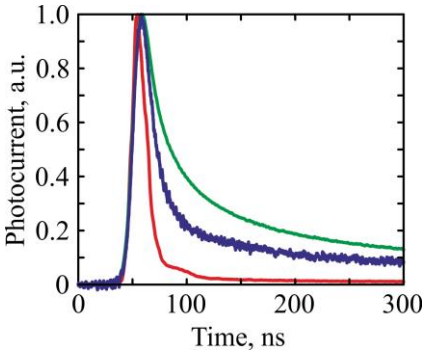

Fig. 1. Oscillograms of the photocurrent pulses before (green line) and after (blue line) electrochemical hydrogenation. Red line shows temporal profile of the excitation laser pulse.

Electrochemical hydrogenation was carried out in weak solution of sulfuric acid in distilled water. The film was placed as cathode into the electrochemical cell with stainless steel anode. Then the Ag/Pd film (cathode) was hydrogenated at a current density of 0.7 mA/cm^2. After some time interval the film was taken out of electrolyte, washed in distilled water and dried. Further, the shapes of photocurrent pulses were recorded. The photocurrent was excited by *p*- and *s*-polarized 532 nm laser radiation. Then the processes of hydrogenating and measuring were repeated. The phase composition of Ag/Pd films was studied with a D2 PHASER X-ray diffractometer using CuK_α radiation.

The oscillograms of photocurrent pulses before electrochemical hydrogenation and after 870 s are presented in Figure 1. The temporal profile of the laser pulses is presented as well. One can see that before the treatment the photocurrent pulse duration (~35 ns) significantly exceeds the corresponding parameter of the laser pulses (~15 ns). Experiments showed that the electrochemical hydrogenation results in shortening of the current pulse time parameters. The photocurrent pulse duration after 870 s hydrogenation is about 21 ns. It is worth noting that the falling edge shape does not match the one before the treatment. Moreover, the electrochemical hydrogenation results in more than 3 times reduction of the photocurrent pulse amplitude. X-ray diffraction measurements showed reduction of the PdO content in the Ag/Pd film with hydrogenation time increase. These pulse changes due to electrochemical hydrogenation can be connected with disappearance of the enhancement effect, which is possible in Schottky barriers formed by PdO and Ag-Pd solid solution.

3. Conclusion

Thus in this work we have shown that the electrochemical hydrogenation of Ag/Pd nanocomposite leads to shortening of nanosecond laser excited photocurrent pulse and changing of its temporal profile.

3. Acknowledgement

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4. References

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