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Influence of PdO Content on the Helicity-Dependent Photocurrent in Resistive Ag/Pd Films

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1. Introduction

Recently, the helicity-dependent photocurrent which is generated in nanostructured film materials was studied. Such helicity-dependent photocurrent is named as a circular photocurrent (CPC).

In our studies [1–3] it was shown that in the porous silver-palladium (Ag/Pd) films, produced according to the thick-film technology, the CPC can be excited by nanosecond laser pulses in a wide spectral range. It was found out that the photocurrent appears in Ag/Pd films containing PdO nanocrystals [4]. However the nature of influence of PdO content on the CPC was not determined.

The aim of this work is to study influence of PdO content on the CPC in Ag/Pd resistive films.

2. Experimental and results

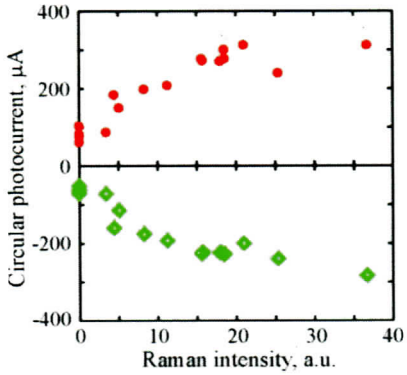

Fig. 1. The photocurrent induced by 1 MW pulsed laser radiation for (red circles) left-hand and (green rhombus) right-hand circularly polarized light vs. intensity of PdO Raman peak

Ag/Pd resistive films were produced in accordance to thick film technology [5] based on burning of a special paste on a ceramic substrate. The size of the film obtained was 12.5×11 mm. The thickness of the film 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.

To change PdO content in the films obtained we used a method based on chemical reduction of Pd from PdO [6] according to the following chemical reaction: $PdO + H \rightarrow Pd + H_2O$. To this end studying film was hydrogenated in the electrolytic sell filled with weak solution of sulfuric acid in distilled water. After some time gap t the film was taken out of electrolyte, washed in distilled water and dried. Further interelectrode resistance and photocurrent were measured (the measuring photocurrent is described in [1–3]), and the Raman spectra of the films were obtained. Then the processes of hydrogenating and measuring were repeated.

Fig.1 represents the dependences of the photocurrent on intensity of Raman-active mode B_{1g} of PdO crystals [7]. Raman intensity of PdO peak represents relative PdO content in the film surface layer. It can be seen that the decrease of PdO content on the film surface leads to the photocurrent decrease. However when PdO content reached zero, the photocurrent was still observable (Fig.1). In our case Raman scattering appears in the film within the skin depth h_R determined by the exciting wavelength of 632.8 nm. But the CPC induced by the light absorption appears in the skin depth h_{PD} determining by the exciting laser wavelength of 532 nm. Since $h_R > h_{PD}$, it is clear that the CPC can be excited in the film without PdO. Therefore the photocurrent appears in the porous structure consisting of Ag-Pd solid solution. The CPC decreasing due to PdO removing effect can be connected with disappearing of the enhancement effect which is possible in Schottky barriers into the film.

3. Conclusion

Thus in this work we showed that the decrease of PdO content in the film surface layer leads to the photocurrent decrease. Nevertheless, the photocurrent is observed at total PdO absence on the film surface. The porous structure of the Ag-Pd solid solution is responsible for the CPC generation.

3. Acknowledgement.

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