DOI: 10.34854/ICPAF.51.2024.1.1.214

CHANGES IN PLASMONIC EXCITATIONS IN CARBON AND TUNGSTEN AS A RESULT OF PLASMA SURFACE TREATMENT *)

Afanas'ev V.P., Lobanova L.G., Budaev V.P., Fedorovich S.D., Semenov-Shefov M.A.

National Research University "Moscow Power Engineering Institute", Moscow, Russia, universe@mpei.ac.ru

Carbon-based materials are of broad interest in the research of physicists, chemists and materials scientists. Carbon-containing coatings have a range of useful structural characteristics. Corrosion of carbon coatings under the influence of thermonuclear plasma leads to hydrocarbon coatings on fusion plant parts, leading to the tritium problem [1]. The surface of tungsten under the influence of plasma can change to a "fluff" type state. The question arises about the change in the allotropic appearance of tungsten occurring as a result of plasma treatment.

The principles of analysis of carbon, carbon-containing, boron-containing and tungsten samples by X-ray photoelectron spectroscopy (XPS) are considered. Allotropic varieties of materials are analyzed. Along with standard XPS approaches based on the consideration of peaks of photoelectrons that have escaped into vacuum without inelastic energy loss, a wide region of photoelectron energy loss (PES analysis) is investigated. An analytical technique for deciphering the XPS signal based on the small-angle approach is constructed.

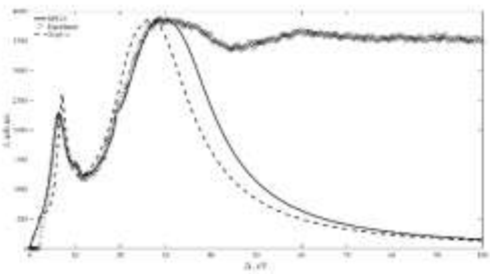

Fig. 1. Inelastic energy loss cross-section of "МПГ-8", recovered from the XPS spectrum, and graphite.

Fig. 1 indicates that PES analysis allows unambiguous determination of the allotropic species of carbon. Fig. 1 demonstrates that the inelastic energy loss cross section of "МПГ-8" after plasma treatment is identical to that of graphite. Note that in [2] PES analysis allowed us to unambiguously determine that the XPS spectrum of reduced graphene oxide almost coincides with the XPS spectrum of "МПГ-8"; however, the density of the obtained material is several times less than that of graphite. This fact indicates the nanoscale information obtained on the basis of the XPS analysis. Examples of sample identification by the area of energy loss in the XPS spectra are considered in the paper. The presence of impurities in the carbon sample leads both to chemical shift of the peak and to distortion of the inelastic energy loss cross section in the region from 0 to 10 eV - the $\pi+\sigma$ hybridization region is practically unchanged.

The results of the XPS analysis of tungsten "fluff" are presented. It is shown that the structure of plasmonic excitations in "fluff" is significantly different from tungsten. It is demonstrated that as a result of contact with the atmosphere, more radical changes occur in the "fluff" than in the original tungsten sample.

This work was financially supported by the Ministry of Science and Higher Education of the Russian Federation (FSWF-2023-0016).

References

[1]. Rosanvallon S. et.al., Fusion Sci. Tech., 2011, 60, 855.
[2]. Afanas'ev V.P. et.al., J. Surf. Invest.: X-Ray, Synchrotron Neutron Tech., 2020, 14, 366.

*) abstracts of this report in Russian