Porous silicon and graphene-based structures for novel plasma energetic systems

R.S. Smerdov[1], A.S. Mustafaev[1], Yu.M. Spivak[2], V.A. Moshnikov[2]

[1] *Saint Petersburg Mining University, Saint Petersburg, Russia*

[2] *Saint Petersburg Electrotechnical University "LETI", Saint Petersburg, Russia*

Applying the effect of photon-enhanced thermionic emission (PETE) for solar concentrator systems makes it possible to utilize both photovoltaic and thermionic effects for energy conversion, leading to a significant increase in its efficiency [1, 2]. The possibility of synthesizing PETE-based systems with semiconductor (GaN) electrodes was demonstrated in [1], however, the number of incident photons with energies exceeding the band gap of GaN (E_g = 3.3 eV) is less than 1 % of their total amount. That is why further investigation of porous silicon (PS), as well as PS-based composite structures for subsequent electrode manufacture is promising, since band gap modification of such materials is possible in the wide range from 1 to 3 eV due to the presence of the quantum confinement effect [3] and significant capabilities for surface functionalization [4]. The synthesis of anodes for thermionic plasma energy systems requires the creation of highly specific materials with low electron work function (φ_a). The problem of φ_a reduction is traditionally solved by the use of alkaline and alkaline-earth metal coatings, in particular, cesium (Cs) [5]. Anodes based on cesium-coated tungsten are traditionally used due to their high thermal stability and relatively low work function (1.7 eV). The use of a nickel anode coated with graphene layers intercalated by cesium atoms made it possible to obtain an unprecedented decrease in the electron work function (φ_a<1 eV) from the surface of the material and, as a consequence, a threefold increase in energy conversion efficiency (up to 25%) [5].

References

1. Schwede J W, Bargatin I, Riley D C, Hardin B E, Rosenthal S J 2010 Photon-enhanced thermionic emission for solar concentrator systems *Nature Mater*. **9** 762

2. Mustafaev A, Smerdov R, Klimenkov B 2017 Semiconductor nanostructures for plasma energetic systems BAPS **62**

3. Nolan M, O'Callaghan S, Fagas G, Greer J C 2007 Silicon nanowire band gap modification *Nano Lett.* **7** 34

4. Spivak Yu M, Mjakin S V, Moshnikov V A et al. 2016 Surface Functionality Features of Porous Silicon Prepared and Treated in Different Conditions *J. of Nanomaterials* **8**

5. Mustafaev A S, Polishchuk V A, Tsyganov A B, Yarygin V I, Petrov P A 2017 *Russian Journal of Physical Chemistry B* **11** 118