Thermal stability of photon-enhanced thermionic emission from Cs/GaAs and GaAs(Cs,O) surfaces

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Gallium arsenide surfaces with adsorbed cesium overlayers were used for several decades as a model system for studying initial stages of metal-semiconductor interface formation and as a basis of *p*-GaAs(Cs,O) photocathodes with negative effective electron affinity, which are widely used in the electron sources with low energy spread, high current density and high spin polarization. The semiconductor surfaces with a relatively small positive electron affinity have recently attracted attention anew due to the opportunity of increasing solar energy conversion efficiency using the photon-enhanced thermionic emission (PETE) [1]. The Cs/GaAs system seems suitable for PETE solar energy converters because the GaAs band gap is close to the optimal value and the effective affinity can be adjusted by the deposition of a submonolayer Cs coverage. The main problem of the Cs/GaAs system consists in its thermal instability [2]. A possible solution of this problem consists in using GaAs(Cs,O) surface, because the small doses of oxygen deposited on the Cs/GaAs surface increase the binding energy of cesium adatoms. To study the thermal stability of electron emission from the Cs/GaAs and GaAs(Cs,O), in this work we measured the temperature dependences of the electron affinity and the electron escape probability on these surfaces. The affinity and escape probability are determined by means of quantum yield spectroscopy under heating to 120°C and subsequent cooling down to room temperature. The photoemission quantum yield spectra are measured on uniformly doped *p*-GaAs(001) epitaxial layers with hole concentration $p = 7\times10^{18}\text{cm}^{-3}$. It was shown that the electron affinity at GaAs(Cs,O) surface decreases by about 30 meV and escape probability remains the same after the thermocycling. This result confirms that at elevated temperatures the PETE from the GaAs(Cs,O) surface is more stable as compared to the Cs/GaAs surface.

References:
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