

**European Materials Research Society Spring Meeting, E-MRS Spring 2014
Symposium BB
Materials by design for energy applications through theory and experiment**

Synthesis and electrical characterizations of a low work function cesium oxide coating for high efficiency thermionic energy converter

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Abstract

One main challenge associated to solid-state thermoelectric materials is to combine electron-crystal electrical conductivity and phonon-glass thermal properties that are difficult to conciliate. A markedly different principle of thermoelectric conversion is based on the micro-thermionic generator that exploits electron injection and heat rejection across two electrodes, hot and cold, immersed in vacuum [1]. To properly operate thermionic emission converters near room temperature, highly efficient emitting electrodes must be integrated. This naturally motivates the development and characterization of coatings that feature a very low work function (WF). Even better than alkalis like K and Cs, their oxides have been reported to produce work functions as low as 0.4 and 0.9eV [2], respectively. In this paper, the optimal synthesis conditions of Cs₂O are first determined from the theoretical volatility diagram. In a second part, we present experimental results on the composition and electrical properties of cesium oxide thin film synthesized in ultra high vacuum. To finalize the study, it is shown that a consistent work function value is extracted based on three independent techniques, namely, thermionic emission, photoemission and Kelvin probe measurements.

[1] T. Zeng, App. Phys. Lett. 88, 153104 (2006)

[2] J.X. Wu et al, Appl. Surf. Sci. 173, 8 (2001)