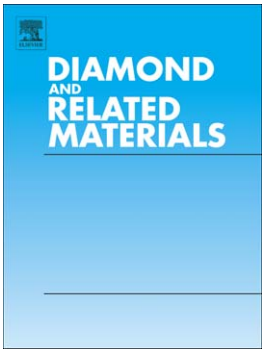

Heavily phosphorus-doped nano-crystalline diamond electrode for thermionic emission application

Hiromitsu Kato, Daisuke Takeuchi, Masahiko Ogura, Takatoshi Yamada, Mitsuhiro Kataoka, Yuji Kimura, Susumu Sobue, Christoph E. Nebel, Satoshi Yamasaki

PII: S0925-9635(15)30015-7
DOI: doi: 10.1016/j.diamond.2015.08.002
Reference: DIAMAT 6437

To appear in: *Diamond & Related Materials*

Received date: 3 July 2015
Revised date: 7 August 2015
Accepted date: 8 August 2015

Please cite this article as: Hiromitsu Kato, Daisuke Takeuchi, Masahiko Ogura, Takatoshi Yamada, Mitsuhiro Kataoka, Yuji Kimura, Susumu Sobue, Christoph E. Nebel, Satoshi Yamasaki, Heavily phosphorus-doped nano-crystalline diamond electrode for thermionic emission application, *Diamond & Related Materials* (2015), doi: 10.1016/j.diamond.2015.08.002

Heavily phosphorus-doped nano-crystalline diamond electrode for thermionic emission application

Hiromitsu Kato[1], Daisuke Takeuchi[1], Masahiko Ogura[1], Takatoshi Yamada[2], Mitsuhiro Kataoka[3], Yuji Kimura[3], Susumu Sobue[3], Christoph E. Nebel[4], and Satoshi Yamasaki[1]

1 Advance power electronics research center, AIST, Tsukuba, 305-8568, Japan.

2 Nanotechnology Research Institute, AIST, Tsukuba, 305-8568, Japan.

3 DENSO CORPORATION, Nisshin, Aichi 470-0111, Japan.

4 Semiconductor Sensors, Fraunhofer IAF, Freiburg 79108, Germany.

Abstract

Thermionic energy conversion is one of the promising technologies for transforming thermal energy into electrical energy. A stable cathode electrode with high conductivity and low work function is required to realize this application. It is already well known that hydrogen-terminated diamond exhibits negative electron affinity, which is a great advantage of an electron emission electrode. In this study, we focus on phosphorus doping, which gives n-type donors with 0.57 eV in single crystal diamond to control the conductivity of diamond, in an attempt to develop a nano-crystalline diamond (NCD) electrode for thermionic emission by heavily phosphorus doping. Phosphorus concentration and structural characterization were performed by secondary ion mass spectroscopy and Raman spectroscopy, respectively. The thermionic emission properties were characterized in vacuum as a function of cathode temperature from 300 to 600 ^{o}C. The work function of heavily phosphorus-doped NCD electrode was estimated based on the Richardson-Dushman equation, and the effect of heavily phosphorus doping on thermionic emission was briefly discussed.