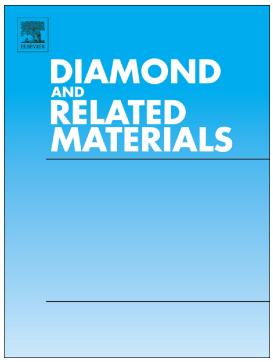

Growth processes of nanocrystalline diamond films in microwave cavity and distributed antenna array systems: A comparative study

B. Baudrillart, A.S.C. Nave, S. Hamann, F. Bénédic, G. Lombardi, J.H. van Helden, J. Röpcke, J. Achard

PII: S0925-9635(16)30542-8
DOI: doi: 10.1016/j.diamond.2016.11.018
Reference: DIAMAT 6767

To appear in: *Diamond & Related Materials*

Received date: 9 October 2016
Revised date: 27 November 2016
Accepted date: 30 November 2016

Please cite this article as: B. Baudrillart, A.S.C. Nave, S. Hamann, F. Bénédic, G. Lombardi, J.H. van Helden, J. Röpcke, J. Achard , Growth processes of nanocrystalline diamond films in microwave cavity and distributed antenna array systems: A comparative study. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Diamat(2016), doi: 10.1016/j.diamond.2016.11.018

Growth processes of nanocrystalline diamond films in microwave cavity and distributed antenna array systems: a comparative study

B. Baudrillart[1], A.S.C. Nave[2], S. Hamann[2], F. Bénédic[1,*], G. Lombardi[1], J.H. van Helden[2], J. Röpcke[2] and J. Achard[1]

[1] LSPM-CNRS, UPR 3407, Université Paris 13, Sorbonne Paris Cité, 99 Avenue J. B. Clément, 93430 Villetaneuse, France

[2]Leibniz Institute for Plasma Science and Technology (INP Greifswald), Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany

[*] corresponding author. E-mail: fabien.benedic@lspm.cnrs.fr

Keywords: nanocrystalline; diamond film; plasma CVD; microstructure; optical emission; reactor modelling

Abstract

The growth process of nanocrystalline diamond (NCD) films has been investigated and compared in two different types of microwave plasma reactors. One process occurs at high substrate temperature (1170 K) and moderate pressure (few hundreds hPa) in a bell jar (BJ) microwave cavity system working in an $Ar/H_2/CH_4$ gas mixture. The second process occurs at low substrate temperature (below 670 K) in a low pressure (< 100 Pa) microwave distributed antenna array (DAA) reactor using a mixture of $H_2/CH_4/CO_2$ as feed gas.

NCD films synthesized in both reactors show a grain size around 20 nm and a strong <110> fiber axis, whereas some slight disparities are observed concerning the film morphology, topography and purity. However, the growth rate is about 30 times higher in the BJ reactor. Similarities and disparities are discussed by considering possible growth mechanisms and the activation energy estimated at 3.2 and 9.0 $kcal.mol^{-1}$ for the DAA and BJ reactors, respectively, for the considered substrate temperatures.

The microwave discharges were investigated by plasma modeling in case of the BJ reactor and by optical emission spectroscopy (OES) in the visible spectral range and laser absorption spectroscopy in the mid-infrared spectral range (MIR-LAS) in the case of the DAA reactor in order to determine major and key species densities as well as the gas temperature nearby the