



**HAL**  
open science

## Improved electronic properties of p-epitaxial layers grown on HPHT (100) substrates after a surface pretreatment

Cyrille Barbay, Christine Mer-Calfati, Nicolas Tranchant, Samuel Saada, Jean-Charles Arnault, Ingrid Stenger, Verena Zuerbig, N. Lang, Lutz Kirste, Oluwasayo Loto, et al.

### ► To cite this version:

Cyrille Barbay, Christine Mer-Calfati, Nicolas Tranchant, Samuel Saada, Jean-Charles Arnault, et al.. Improved electronic properties of p-epitaxial layers grown on HPHT (100) substrates after a surface pretreatment. SBDD XXIII - Hasselt Diamond Workshop 2018, Hasselt university, Mar 2018, Hasselt (Belgium), Belgium. pp.147. cea-04162058

**HAL Id: cea-04162058**

**<https://cea.hal.science/cea-04162058v1>**

Submitted on 13 Jul 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## Improved electronic properties of p- epitaxial layers grown on HPHT (100) substrates after a surface pretreatment

Cyrille Barbay<sup>1</sup>, Christine Mer-Calfati<sup>1</sup>, Nicolas Tranchant<sup>1</sup>, Samuel Saada<sup>1</sup>, Jean-Charles Arnault<sup>1</sup>, Ingrid Stenger<sup>2</sup>, Verena Zuerbig<sup>3</sup>, N. Lang<sup>3</sup>, Lutz Kirste<sup>3</sup>, Oluwasayo Loto<sup>4</sup>, David Eon<sup>4</sup>

<sup>1</sup>CEA, LIST, Diamond Sensors Laboratory, F-91191 Gif-sur-Yvette, France

<sup>2</sup>Groupe d'Etude de la Matière Condensée, Université de Versailles St Quentin, CNRS, Université Paris-Saclay, 45 avenue des Etats-Unis, 78035 Versailles cedex, France

<sup>3</sup>Fraunhofer Institute for Applied Solid State Physics IAF, 79108 Freiburg, Germany

<sup>4</sup>Institut Néel, Université Grenoble Alpes, 25 Avenue des Martyrs, BP 166, 38042 Grenoble, France

[cyrille.barbay@cea.fr](mailto:cyrille.barbay@cea.fr)

Single-crystal diamond synthesis of high crystalline quality remains a challenge for power electronic devices<sup>1</sup>. Usually, HPHT diamond substrates will undergo a mechanical polishing step which induces plastic deformation and dislocations in the subsurface at few microns depth<sup>2</sup>. During Chemical Vapour Deposition (CVD) growth, these dislocations might thread into the epilayers<sup>3</sup> and emerge as pyramidal hillocks<sup>4</sup> affecting the devices electronic performance<sup>5</sup>. Consequently, removing this defective layer and reaching very smooth substrate surface before growth<sup>6</sup> is primordial to better control the crystalline quality of diamond epitaxial layers.

In this work, we investigated the effect of Ar/O<sub>2</sub> etching on HPHT (100) Ib Sumitomo substrates by optimizing the RF-power, the pressure and the O<sub>2</sub> content in regard to the etching rate and RMS roughness. This surface pretreatment provides fast etching rates up to 9 μm/h and results in smooth surfaces according to AFM measurements (RMS roughness from 3.5 to 2 nm on 40x40 μm<sup>2</sup> images).

Ar/O<sub>2</sub> etching with optimal conditions was used to lead a comparative study on two half-etched HPHT (100) substrates of different suppliers (Sumitomo Ib and New Diamond Technology IIa). Pretreatment efficiency was tested on both of them by evaluating the enhancement of crystalline quality using Raman Spectroscopy and High Resolution X-ray Diffraction.

The crystalline quality of low boron doped (10<sup>16</sup> cm<sup>-3</sup>) epilayers (2 μm thick) grown simultaneously on the two etched substrates was studied by Raman and Cathodoluminescence and compared with non-treated substrates. SEM voltage contrast is used to highlight the threading dislocations on non-pretreated areas and their removal after etching (Figure 1). Electronic properties were also investigated by Hall measurements and show a clear improvement in term of carrier mobility and resistivity (from 3 to 1.7 Ω.m) on pre-etched area of Ib Sumitomo substrates.

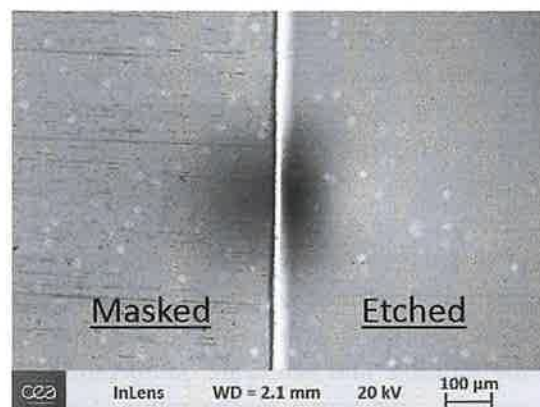


Figure 1: SEM image of half-etched Sumitomo substrate at 20 kV

**This project has received funding from the European Union's Horizon 2020 Program under Grant Agreement no. 640947 (Greendiamond).**

### References

- [1] M. Schreck et al., MRS Bulletin 39 (2014) 504; [2] I.Friel et al., Diamond and Related Materials 18 (2009) 808; [3] M. P. Gaukroger et al., Diamond and Related Materials 17 (2008) 262; [4] A. Tallaire et al., Diamond and Related Materials 17 (2008) 60; [5] M. Suzuki et al., Physical Status Solidi a 210 (2013) 2035 [6] K. Nakanishi et al., Diamond and Related Materials 68 (2016) 127