Diamond heteroepitaxy on up-scalable Ir / $SrTiO_3$ / Si (001) multilayer

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Diamond has multiple properties such as wide bandgap, high thermal conductivity, large electron and hole mobilities and high breakdown field. For its unique properties, it can be used as power electronics and radiation detectors. With the technological advancements of these applications, large surface monocrystalline diamond is required for further development. Heteroepitaxy is currently a promising method for synthetizing large surface "monocrystalline" diamond.

High quality diamond films can be grown by heteroepitaxy on epitaxial iridium buffer layers. Among the potential substrates, single crystal bulk $SrTiO_3$(001) is a great candidate for iridium epitaxy[1]. However, for further up-scaling, thin $SrTiO_3$ films grown by MBE on silicon are a great alternative due its low mosaicity (FWHM of the rocking curve (ω) measured by XRD (tilt)=0.26°).

Diamond heteroepitaxy process consists in different steps. First, an epitaxial iridium film (70-200nm) (tilt=0.33° and FWHM of the azimuthal curve (ϕ), twist=0.09°) is deposited on $SrTiO_3$(40nm)/Si(001) substrates. Then BEN (Bias Enhanced Nucleation) treatment is performed in a Microwave Plasma CVD reactor with a bias voltage of -290V, forming highly homogeneous and dense domains on the epitaxial iridium film (Figure 1) composed of oriented diamond nuclei[2]. These nuclei are then thickened in a MPCVD reactor (Figure 2). Heteroepitaxial diamond films grown on Ir/$SrTiO_3$/Si(001) were characterized by HRSEM, HRTEM, XRD and Raman.

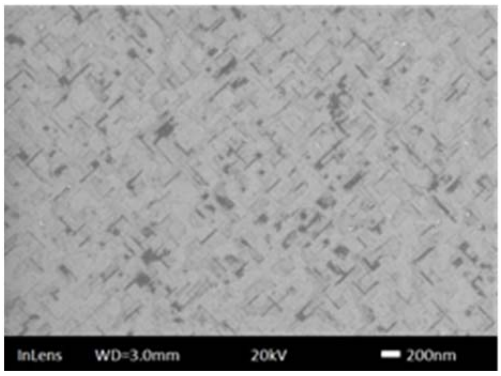

Figure 1: SEM image of domains on Ir/$SrTiO_3$/Si

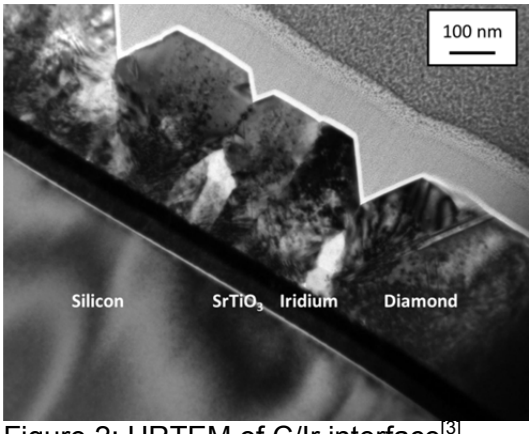

Figure 2: HRTEM of C/Ir interface[3]

1. H. Bensalah, et al., "Investigation of dislocations and strain in heteroepitaxial diamond grown on Iridium", International Conference on Diamond and Carbon Materials, Madrid, Spain, Sept 7-11, 2014, Oral session 9A
2. N. Vaissiere, et al., "How hydrogen plasma can reveal diamond nuclei on iridium?", International Conference on Diamond and Carbon Materials, Lake Garda, Italy, 2013
3. O. Brinza, et al., "HRTEM Analysis of Interface Between Heteroepitaxial CVD Diamond and Monocrystalline Iridium Buffer Layer", 2015 MRS Spring Meeting & Exhibit, San Francisco, California, USA, April 6-10, 2015, CC10.03