Supplementary Materials for: Orders of magnitude reduction in the thermal conductivity of polycrystalline diamond through carbon, nitrogen, and oxygen ion implantation

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Contents

1. High resolution x-ray diffraction (HRXRD) measurements

1.1. (111) HRXRD measurements, RADS simulations

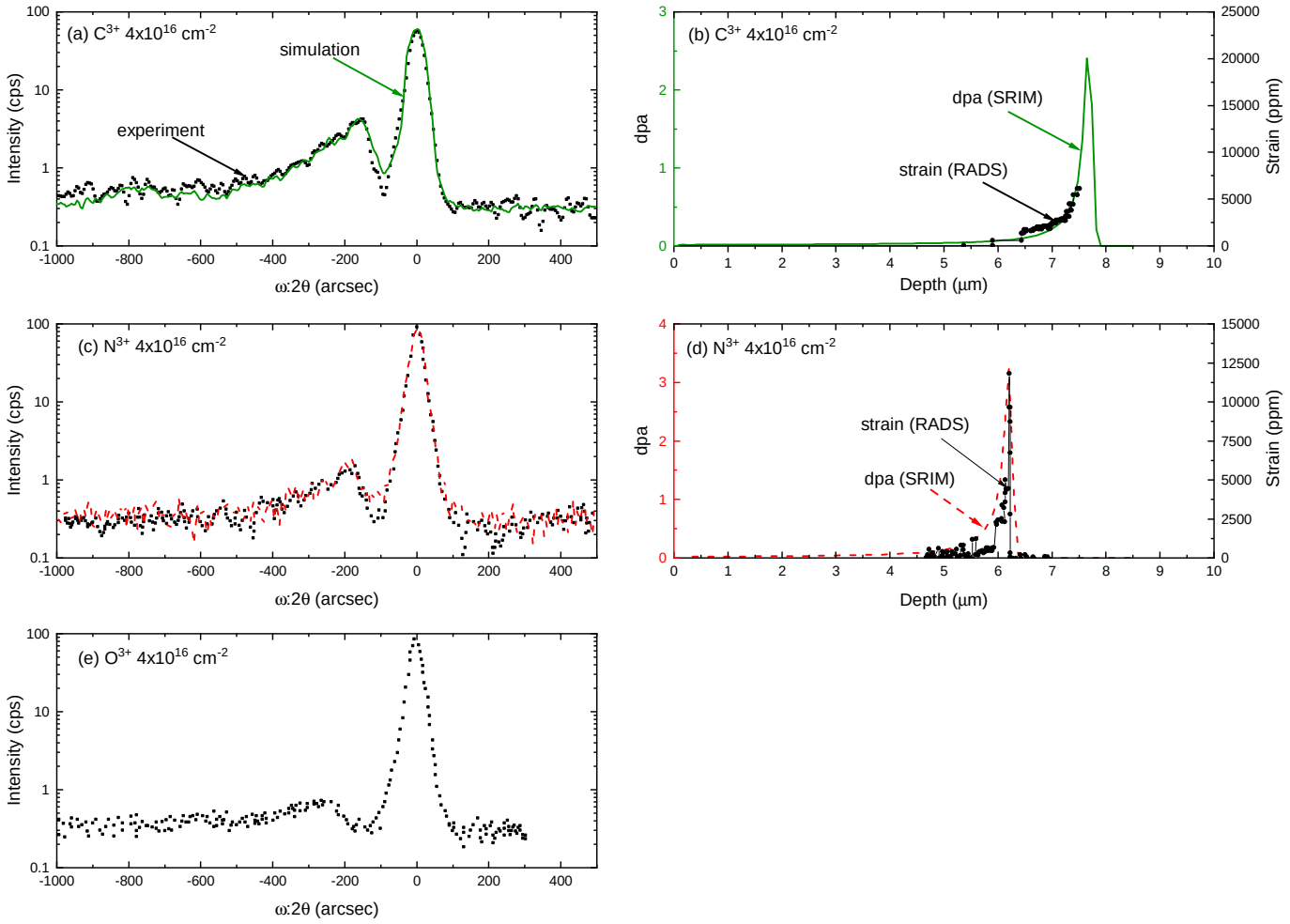

Figure 1: HRXRD measurements of the (111) peak (a,c,e), and corresponding RADS simulations of sample strain (b,d). In (a), (c), and (e), the experimental HRXRD data is represented by black squares, the lines plotted atop the experimental data display the RADS model of the data, from which the strain is simulated. For comparison, the dpa (calculated via SRIM), is plotted along with the strain in (b) and (d); in each case, there is negligible strain expected prior to the end of range. The strain intensity for the O^{3+}implanted sample was found to be too low to adequately model with RADS, and therefore a strain profile could not be generated.

2. Plan-view scanning eletron microscopy (SEM)

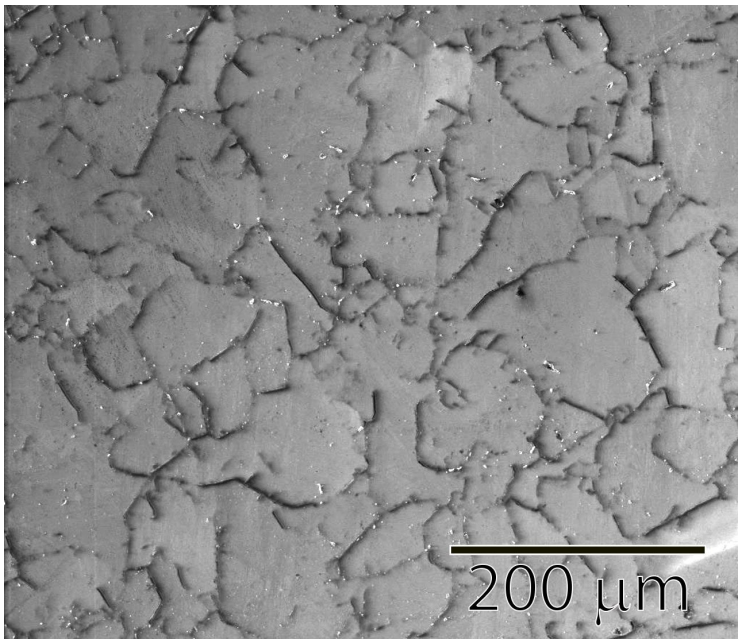

Figure 2: Plan view SEM image of the surface of a diamond wafer. The dark lines, indicating grain boundaries, suggest that grains within the material are on the order of tens of μm, consistent with other measurements of grain size of polycrystalline CVD grown sythetic diamonds in the literature [1, 2, 3]. From kinetic theory approximation ($\kappa = 1/3 C_v v l$ where κ is thermal conductivity, C_v is volumetric heat capacity, v is sound speed in the material, and l is phonon mean free path), the mean free path is found to be 0.28 μm, when using the unirradiated thermal conductivity (1,996 W m^{-1} K^{-1}), and taking the volumetric heat capacity and sound speed as 1.78×10^6 J m^3 K^{-1} and 12,000 m s^{-1}, repsectively. This suggests that from a thermal perspective, the sample can be considered as bulk.

References

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