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Relation between Crystal Facet and Electrical Property of Boron Doped CVD Diamond

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Doping is an essential process for electrical applications. For diamond, boron is the only known proper dopant. Boron can be introduced into diamond by ion implantation and in-situ doping method. In the case of in-situ doping, it is very difficult to control boron incorporation ratio in the films from boron hydride or other types of boron compound. Morevoer, the incorporation is related closely with the growth kinetics of diamond and, thus, depends on the crystal facet index.

In this study, we investigate the effect of boron in the gas phase on the crystal habit change and analyze the incorporation ratio as well as electrical property according to the crystal facet both in the case of a separate particle and polycrystalline diamond film. This is very important in designing polycrystalline diamond semiconductor devices. We use diborane gas as a dopant source. A typical tube type microwave plasma assisted chemical vapor depostion is used for diamond deposition with the pressure of 70 torr.

With increasing boron to carbon (B/C) ratio in the gas phase, the {111} facet tends to dominate over {100} facet. The ratio of growth rate of {111} to {100}, thus, decreases with increasing B/C ratio. Since the incorporation ratio on {111} crystal appears larger than that on {100}, the chemisorption of boron on the surface is assumed to be more intense on {111} facet than {100} facet, which slows carbon radical deposition for diamond deposition. The effect of B/C ratio on the quality of diamond is also investigated. We also suggest the electrical property of polycrystalline diamond film.