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Diamond and Other Carbon Nanostructures Produced by Chlorination of Carbides

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Synthesis of nano- and microcrystalline sp^3-bonded carbon (diamond) with cubic and hexagonal structure by extraction of silicon from silicon carbide in chlorine-containing gases has been reported recently [1,2]. This process is attractive because it can produce diamond at ambient pressure and at temperatures below 1000ºC. No plasma or other high-energy activation is required, thus providing an opportunity for large-scale synthesis. However, the mechanism of diamond formation has not been fully understood. This paper reports on the formation mechanisms of diamond, as well as transformation of diamond to graphite and onion-like carbon upon heating. Study of SiC/carbon interfaces showed that direct epitaxial growth of diamond on SiC is possible, in agreement with previous molecular dynamics simulation. However, random nucleation of diamond from amorphous sp^3-bonded carbon produced as the result of extraction of Si from SiC has also been demonstrated. It has been shown that presence of hydrogen in the environment is not required for diamond synthesis. However, hydrogen can stabilize the nanocrystals and lead to the growth of thick diamond layers. If no hydrogen added, diamond nanocrystals transform to graphite, forming carbon onions and other curved graphitic nanostructures. Formation of other structures, such as carbon nanotubes [3], will be discussed.

References

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