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Discoveries of Q-Carbon and Q-BN and High-temperature BCS Superconductivity B-doped Q-carbon †

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Abstract: We present the discovery of a new phase of carbon (Q-carbon) and BN (Q-BN) and the direct conversion of carbon into diamond and h-BN into c-BN. At ambient temperatures and pressures in the air [1-2]. Amorphous carbon or nanocrystalline h-BN films are melted in a super undercooled state by nanosecond laser irradiation quenched into a diamond (or Q-carbon) and h-BN into c-BN (or Q-BN), depending upon the degree of undercooling. By this process, diamond and c-BN can be formed as NV nanodiamonds, micro diamonds, nanoneedles and microneedles, and large-area single-crystal films. These phases can be doped with both n- and p-type dopants, opening a new frontier in diamond and c-BN electronics. We discuss the atomic structure and bonding characteristics of Q-carbon and correlations with unique properties: harder than diamond (.30%), RTFM, and extraordinary Hall effect with Curie temperature over 500K, negative electron affinity, and enhanced field emission. Undoped Q-carbon is ferromagnetic, and upon doping with boron, it turns paramagnetic and exhibits record BCS high-temperature superconductivity. We have created three distinct phases: 17% atomic B-doped Q-carbon (T_c =37K), 25% atomic B (T_c= 57K); and 50% atomic B (T_c > 100K estimated). We have also created epitaxial <111> NV nanodiamonds of uniform size (4-10nm), driven electronically and photonically for applications ranging from biosensors to quantum computing. Similar results are presented for Q-BN and c-BN with a strong synergy between carbon and BN. The focus of this presentation is on the characteristics of NV nanodiamonds for quantum computing and details of high-temperature superconductivity, where T_c is being enhanced through a higher density of states near the Fermi Level, higher Debye temperature, and phonon frequency in strongly-bonded lightweight materials. From the critical current density *versus* field moments, the value of critical current density (J_c (2T)) in B-doped Q-carbon at 21 K is calculated as 4.3×10^7 Acm^{-2}, which indicates that this novel material can be used for the persistent mode of operation in MRI and NMR applications. This discovery of high-temperature superconductivity in B-doped amorphous Q-carbon shows that a non-equilibrium synthesis technique using the super undercooling process can be used to fabricate materials with greatly enhanced physical properties.

Keywords: nandiamonds; microdiamonds; nanoneedles (List three to ten pertinent keywords specific to the article; yet reasonably common within the subject discipline.)

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Conflicts of Interest

The authors declare no conflict of interest.

References

1. Narayan, J.; Bhaumik, A. Novel phase of carbon, ferromagnetism, and conversion into diamond. *Journal of Applied Physics*, **2015**, *118*, 21, 215303.
2. Bhaumik, A.; Sachan, R.; Narayan, J. Discovery of high-temperature superconductivity (T c= 55 K) in B-doped Q-carbon. *ACS nano*, **2017**, *11*, 12, 11915-11922.