

i. Metacognition. Why...?
ii. Studies of C, B&N, dissolved in metal flux (...growth of diamond, cubic boron nitride, hexagonal-diamond, wurtzite-type BN: by new methods?)

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(i) **Metacognition**—*Thinking about my thinking* on faceted CNTs [1,2], and electrochemical reduction of C_{60} up to C_{60}^{6-} (work in progress). We celebrate what we created—but what did we overlook, and (*why?*). [1,2]. *Nature* **1993**, 364 (6437), 514-516. DOI: [10.1038/364514a0](https://doi.org/10.1038/364514a0). *Physical Review Letters* **1994**, 73 (5), 676-679. DOI: [10.1103/PhysRevLett.73.676](https://doi.org/10.1103/PhysRevLett.73.676)

(ii) **On Earth circa 2025**, far more natural graphite (G) than diamond (D) is mined/processed, and far more synthetic G than D is made. In metric tons: ~1,500,000 to ~24 (G to D, natural) and ~3,500,000 to ~3,100 (G to D, synthetic).

D&G are almost isoenergetic at 273K and 1 atm and the same is true for hexagonal boron nitride (hBN) and cubic boron nitride (cBN). E.g., ΔH_f of D at STP is about the same as ΔH_{vap} of liquid neon at its boiling point of 27K, and about 1/10 the enthalpy of an H-bond in liquid water. (Note that graphite is the standard state at STP.)

My view: The standard explanation for graphite's dominance over diamond (in textbooks, published literature, and answers by ChatGPT, Claude, Gemini, etc.) rests—incorrectly, in my opinion—on the remarkably small difference in Gibbs free energies between infinite, defect-free crystals. In our real world, do we *ever* have such ideal and infinite crystals?

How might we synthesize D in *new ways*. [3] The parameter space for the elemental compositions of metal fluxes that might dissolve the needed amount of C (or for cBN the needed amount(s) of B and/or N) at ~1 atm pressure is *very large* per combinatorics of the relevant elements in the Periodic Table. *Fortunately for opportunities for basic science as well as technology there is a great deal that is "not studied at all" about dissolution of carbon (or boron & nitrogen), phase equilibria, and other interesting issues, in many possible choices of metal fluxes.* [3] *Nature*. 2023, 629, 348-354 DOI: [10.1038/s41586-024-07339-7](https://doi.org/10.1038/s41586-024-07339-7).

With new ideas on controlling the spatiotemporal distribution of solute elements in metal flux from time = 0, combined with *retrosynthesis* (*inverse design* and/or *inverse optimization* are also apt terms), I foresee a promising new horizon for synthesis of diamond and cubic boron nitride.

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