**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?)**
**iii. Tensile loading mechanics of macroscale single crystal graphene**

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(i) Metacognition—*Thinking about my thinking* on [1,2], and about FT-MW spectroscopy of supersonic jet-cooled clusters [3,4,5; a few examples]. We celebrate what we created—but what did we overlook, and (*why?*). **[1,2].** *Nature* **1993**, *364* (6437), 514-516. **DOI: 10.1038/364514a0**. *Physical Review Letters* **1994**, *73* (5), 676-679. **DOI: 10.1103/PhysRevLett.73.676** **[3-5]** *Journal of Chemical Physics* **1988**, *89* (1), 138-148. **DOI: 10.1063/1.455515**. *Journal of Chemical Physics* **1990**, *93* (5), 3142-3150. **DOI: 10.1063/1.458848.** *Journal of Chemical Physics* **1992**, *96* (5), 3441-3446. **DOI: 10.1063/1.461947**.

(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., $\Delta H_f$ of D at STP is about the same as $\Delta H_{vap}$ 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*.[6] 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.* **[6]** *Nature*. 2023, 629, 348-354 **DOI: 10.1038/s41586-024-07339-7.**

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.

(iii) Tensile loading mechanics of large-area monolayer single crystal graphene (SCG) and single crystal monolayer hBN. *Macroscale* SCG is incredibly strong!

**BIOGRAPHY.** Rodney S. Ruoff, UNIST Distinguished Professor (Chemistry, Materials Science, and Energy Science and Chemical Engineering), directs the *Center for Multidimensional Carbon Materials* (CMCM), an IBS Center at UNIST. Prior to joining UNIST in 2014, he was the Cockrell Family Regents Endowed Chair Professor at the University of Texas at Austin from September 2007. He earned his Ph.D. in Chemical Physics from the University of Illinois-Urbana in 1988 and was a Fulbright Fellow in 1988–89 at the Max Planck Institute für Strömungsforschung in Göttingen, Germany. He was at Northwestern University from 2000 to 2007, where he was the John Evans Professor of Nanoengineering and director of NU's *Biologically Inspired Materials Institute*, and conducted research at the Molecular Physical Laboratory, SRI International for six years after a postdoctoral fellowship at IBM TJ Watson Research Center. More at http://cmcm.ibs.re.kr/ and https://en.wikipedia.org/wiki/Rodney_S._Ruoff