Carbon and BN materials: Basic science and broader impact

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At standard temperature and pressure, diamond and graphite, and hexagonal-boron nitride (hBN) and cubic boron nitride (cBN), are very close to being isoenergetic; the same is true at higher temperatures. But there is a perception that it is 'must be' more difficult to form diamond, and perhaps cubic boron nitride, than graphite and hBN, respectively; because in general and to date: this has been true. It is also true that on Earth there is *much* more natural graphite than diamond, and there happens to be much more synthetic graphite produced But must this *always* be so, going forward? I will discuss some interesting things about these allotropes, and then describe how to (perhaps!) synthesize diamond and cBN in new ways.

A separate topic is the ***macros***cale strength of graphene. Many materials exhibit very high strength including ideal strength values, at microscale. We have CVD-grown single crystal and large area graphene (SCG) on Cu(111) and Ni(111) substrates. The centimeter-length scale Young's modulus, and important tensile strength, strain-at-failure, and toughness modulus, are quite literally "out of this world" with strength values 5x to 6x that of the highest strength macroscale material commercially available (Toray ultra-strength carbon fibers having tensile strength of 7.8GPa). The implications for commercial application of SCG are extremely intriguing. I will discuss this in detail.

Supported by the Institute for Basic Science (IBS-R019D1).

Keywords: diamond, cubic boron nitride, metal flux crystal growth, ultrahigh strength macroscale graphene, solid mechanics, fracture mechanics

References

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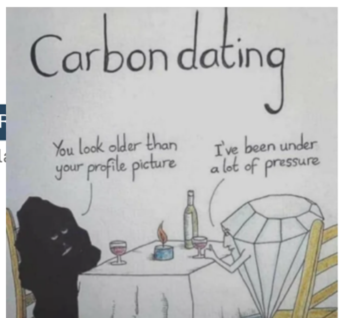
Biography (next page)

BIOGRAPHY. Rodney S. Ruoff, UNIST Distinguished Professor (The Departments of Chemistry and Materials Science, and The School of Energy Science and Chemical



Engineering), directs the *Center for Multidimensional Carbon Materials* (CMCM), an Institute for Basic Science Center (IBS Center) located at the Ulsan National Institute of Science and Technology (UNIST) campus. 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 January 2000 to August 2007, where he was the John Evans Professor of Nanoengineering and director of NU's *Biologically Inspired Materials Institute*, and did research at the Molecular Physical Laboratory, SRI International for 6 years after being a postdoctoral fellow at IBM TJ Watson Research Center. Further information about Rod is at http://cmcm.ibs.re.kr/ and https://en.wikipedia.org/wiki/Rodney_S._Ruoff