Diamond synthesis

K. R. Rao's paper on superhard materials[1] caught my eye as one who has been involved with 'diamond and superhard materials' research for four decades.

May I correct some of Rao's history of the science, and the technology involved? He writes 'Using a combination of physics, supercomputers, and ... one is able to predict materials that are possibly synthesizable and that are hard as or harder than diamond'. History shows that literally nothing could be further from the truth. Using that approach has failed, in forty years, to predict and then make a single phase!!!

The scientific study of materials synthesis is the province of the crystal *chemist*, an entire subject essentially ignored in most universities outside Europe. Victor Moritz Goldschmidt, in Oslo mainly in 1926–27, with later contributions from Linus Pauling, laid down all the fundamentals necessary for every single prediction at the appropriate levels of precision possible. The science of predicting a structure from a given inorganic composition at a prescribed temperature and pressure was what I taught in my beginning graduate course in crystal chemistry at Penn State for 45 years. Using the guaranteed-accurate, only modestly precise, empirical base, our group successfully synthesized more (high temperature) inorganic materials with targeted properties – whether new nanocomposites (clays), new perovskites or new zero expansion phases – than any other.

The track record of the 'physics + computer' crowd is spectacularly poor. One recalls the Linus Pauling–Jim Phillips episode which made a similar point to the one I am making. I was astonished that Rao did not refer to the recent specific case of 'superhard C_3N_4' prediction in which Cohen[2] at Berkeley followed Rao's recipe and Lieber *et al.*[3] at Harvard claimed to have made this phase. Our graduate students, with one course in crystal chemistry and no computers, could have 'predicted', using the real first principles of crystal chemistry what Cohen did, that, at 1–200 kbars, C_3N_4 *may* form in the Si_3N_4 structure and be pretty hard (i.e. in the BN-diamond region). DeVries[4], senior survivor of the original GE diamond synthesis team, showed recently that, by 1997, some 400 papers had been published on this still non-existent material, C_3N_4. By now he estimates that the number of misled and misleading papers exceeds *a* few thousands. That is the price the public pays for hype by scientists, for misleading claims, misplaced epistemology and misplaced trust in 'physics + computers' for predicting complex reality. Gilman[5] has argued the case against the value of computers in such tasks in some detail.

Rao may have also noted that there is a simple correlation between hardness and melting point. Hence Os has been well known as a candidate hard material for decades. By far, the most significant and surprising innovation in the superhard area was also missed: that is the Russian science and Japanese development which brought to the world, CVD diamonds. A dense phase, grown metastably from a very low density vapour – that was new. Everything else in the field of 'superhard' single phase materials has been pretty routine crystal chemistry. Again from those principles one we have been working at some modest advances from nano-composite strategies for some 15 years.

1. Rao, K. R., *Curr. Sci.*, 2002, **82**, 1198–1201.
2. Cohen, M. L., *Phys. Rev. B*, 1985, **32**, 7988.
3. Niu, C., Lu, Y. Z. and Lieber, C. M., *Science*, 1993, **261**, 334.
4. DeVries, R. C., *Mater. Res. Innov.*, 1997, **1**, 161.
5. Gilman, J. J., *ibid*, 2001, **4**, 209.

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NEWS

South Asian Geological Congress

The Fourth South Asian Geological Congress (GEOSAS-IV) was held at New Delhi between 13 and 15 November 2002. More than 300 geologists from South Asia gathered here to discuss different geological issues concerning this region. At the end of the three-day meeting, scientists from the region reiterated the need for better cooperation to tackle common geological concerns.

The GEOSAS was formed in 1992 and its first congress was held in Pakistan. Within a decade the forum has established its viability and emphasized that geological research cannot be confined to the geopolitical boundaries of nations. Joint action plans to study the larger geological concerns of the region are important. The congress was intended to provide a platform for geoscientists from the participating countries to meet and take stock of the geological advances made by the member countries and exchange ideas that are relevant to society. These interactions have already led to greater institutional and personnel interface among geoscientists in this region.

The theme of the congress was 'Quaternary Geology and Dynamics of South Asia'. The region has many common geological attributes and problems. Sharing of geomorphic data amongst the members will be mutually beneficial. For example, arsenic pollution in drinking water is a common problem for India and Bangladesh. Similarly, the problem of spreading of Thar desert to the Sindh province in Pakistan and to Rajasthan in India needs to be studied jointly.

The congress concluded with a plea for greater interaction between scientific institutions and individual scientists in the South Asian region in order to tackle major geological concerns.

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