The Future of Nanocarbon Research and Development

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It is widely believed that the subtleties of carbon bonding are importantly involved in the near miraculous emergence of life on earth. The subtleties of carbon bonding also are fundamentally responsible for the ability of organic chemists to synthesize the many substances without which the existence of our civilization would be inconceivable. The unexpected discovery of the nanocarbons only a few decades ago has ushered in a new age of carbon chemistry and physics whose dimensions and potential impacts on science and society can at present be only dimly perceived. Although the consequences of these basic discoveries are still unfolding before our eyes day by day, it is already clear that the subtleties of carbon bonding are at the root of the complexity and variety of structures and configurations exhibited by the new allotropes of carbon.

This new field of carbon science has received an important impetus due to the series of conferences organized during the last several years in St. Petersburg of which I have been privileged to attend two prior ones. Here, I will give a very personal view of some of the major areas where important progress can perhaps be made by virtue of the remarkable materials properties possessed by the nanocarbons either singly or in combinations. I will stress the latter because the close energetic and bonding relationships between the nanocarbons promote the synergistic emergence of properties leading to the creation of a new class of materials that I choose to call “nanocarbon ensembles”.

In the field of energy, nanocarbon ensembles may lead to good thermoelectric materials for the efficient direct conversion of heat to electricity. When properly doped, they display interesting increases in the power factor even at quite high temperatures seemingly retaining their desirable phonon scattering and high density of states properties characteristic of low dimensional materials. On the other hand, fullerenes and fullerene derivatives have been shown to function well as photovoltaic materials and examples of work illustrative of these results will be briefly reviewed.

In the vital field of communications technology, doped nanodiamonds are being studied for their possible use in quantum computing devices. MEMS and NEMS resonators based on ultrananocrystalline diamond (UNCD) films have been shown to have properties superior to other materials. Carbon nanotubes have been investigated as radiofrequency antennas, receivers and resonators. The magnetic properties of nanographites are of interest for applications in the field of “spintronics”.

Finally, in the field of health care, nanocarbons are certain to play an important role in providing new avenues for the control of diseases due to better avenues for drug delivery as well as biocompatible prosthetic devices for retinal implants, nerve stimulation and low friction load bearing surfaces Examples from current work in these areas will be cited and discussed. (Work performed under the auspices of the US DOE Office of Science under Contract # DE-AC02—6CH11357)