313e A New Method of Synthesizing Diamond Carbon: A Polymer Precursor to Hexagonal Diamond and to Fully-Sp3 Tetrahedral Amorphous Carbon Films

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The processing of a novel polymer, poly(hydridocarbyne), whose microstructure is tailored to include only sp3 carbon, is reported. The network backbone of this polymer is composed of tetrahedrally-hybridized carbon atoms, each bearing one hydride substituent and linked via three carbon-carbon single bonds into a three-dimensional random network of fused rings. The polymer "molecules" exist as nano-sized clusters in organic solvents. The sp3-carbon network backbone confers unusual properties on the polymer, including facile thermal decomposition under inert atmosphere between 100 and 400 oC to form fully sp3 tetrahedral amorphous carbon (ta-C) high quality films at atmospheric pressure, without the use of hydrogen or any activated atoms or reactive atmospheres. No sp2 carbon can be detected in these films by multi-wavelength Raman spectroscopy. The films have also been characterized by XPS, energy-dispersive spectroscopy, microcombustion chemical analysis, AFM, and FE-SEM. If attempts are made to provide nucleation sites within the polymer film during thermolysis, hexagonal diamond is formed, which was characterized by Raman spectroscopy and xray and electron beam diffraction. Poly(hydridocarbyne) is also a precursor to the chemical vapor deposition of hexagonal diamond, again via thermal processing at low temperatures and atmospheric pressure, without the use of hydrogen or any activated atoms or reactive atmospheres. Polymer molecules vaporize upon heating, and nucleate on surfaces downstream from the polymer source. Because poly(hydridocarbyne) is a polymeric species that is readily soluble in organic solvents, it can be easily spun or coated onto large surfaces, dip-coated onto complex shapes, pulled or drawn into fibers, molded into parts, and formed into composites with other materials. The easy thermal processing of this polymer to diamond carbon, and the lack of need for processing by any CVD reactor or activated atmosphere, provides wholly new opportunites and possible uses for diamond-carbon engineered materials.