Chemical Engineering Thesis Defense

Synthesis of Acetylenic Carbon Molecules via Pulsed Laser Ablation in Ethanol

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abstract

New forms of carbon are being discovered at a rapid rate and prove to be on the frontier of cutting edge technology. Carbon possesses three energetically competitive forms of orbital hybridization, leading to exceptional blends of properties unseen in other materials. Fascinating properties found among carbon allotropes, such as, fullerenes, carbon nanotubes, and graphene have led to new and exciting advancement, with recent applications in defense, energy storage, construction, and electronics. Various combinations of extreme strength, high electrical and thermal conductivity, flexibility, and light weight have led to new durable and flexible display screens, optoelectronics, quantum computing, and strength enhancer coating. The quest for new carbon allotropes and future application continues. Despite the advances in carbon-based technology, researchers have been limited to sp3 and sp2 hybridizations. While sp3 and sp2 hybridizations of carbon are well established and understood, the simplest sp1 hybridized carbon allotrope, carbyne, has been impossible to synthesize and remains elusive. This dissertation presents recent results in characterizing a new material produced from using pulsed laser ablation in liquid (PLAL) to ablate a gold surface that is immersed in a carbon rich liquid. The PLAL technique provides access to extremely non-thermal environmental conditions where unexplored chemical reactions occur and produce new materials. A combination of experimental and theoretical results suggests gold clusters can act as stabilizing agents as they react and adsorb onto the surface of one dimensional carbon chains to form a new class of materials termed “pseudocarbynes”. Data from several characterization techniques, including Raman spectroscopy, UV/VIS spectroscopy, and transmission electron microscopy (TEM), provide evidence for the existence of pseudocarbyne. This completely new material may possess outstanding properties, a trend seen among carbon allotropes, that can further scientific advancements.

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