

Advanced Fullerene Production

NSF SBIR Phase II Grant DMI-0321643, AM, 7/03 –

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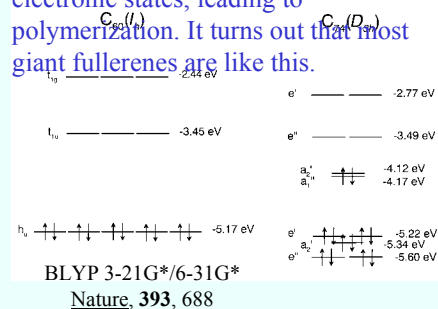
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Technical Outline

With NSF and DOE SBIR assistance, TDA developed a process for manufacturing fullerenes in a sooting flame.

This process is now practiced at a plant producing **40 tons/yr** of soluble fullerenes (C₆₀, e.g.). But many fullerenes are insoluble. In fact, there are almost as many insoluble fullerenes as soluble fullerenes made in the sooting flame.

The “insoluble” fullerenes are even more electrophilic than soluble fullerenes, and have very small energy differences between filled and unfilled electronic states, leading to polymerization. It turns out that most giant fullerenes are like this.



The inter-fullerene bonds can be broken by addition of electrons, closing the fullerenes’ electronic shell, and rendering them soluble as anions. Once soluble, they can be separated from the remaining soot by filtration.

Removing the electrons by oxidation precipitates a black powder of pure “insoluble” fullerenes. Tons of these fullerenes are also being produced.

Now, we need to perform the process economically and at a greater scale. We are also working on isolating specific “insoluble” fullerenes from mixture, and characterizing this new fullerene material.



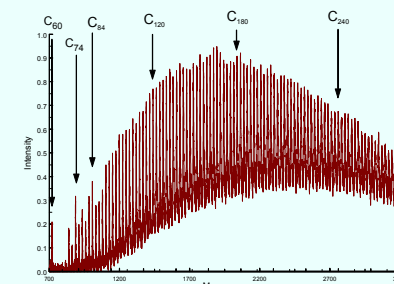
Research flame



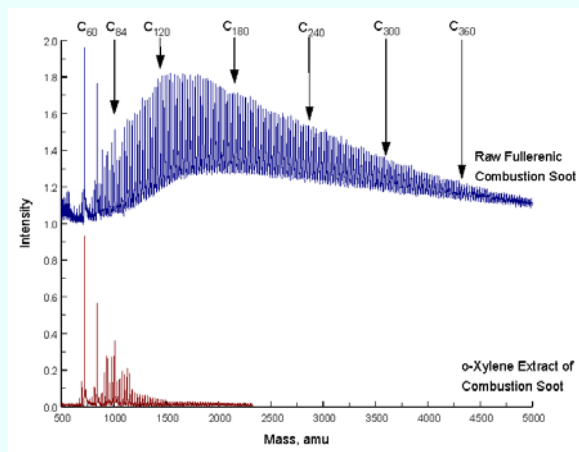
40 T/yr dedicated fullerene plant



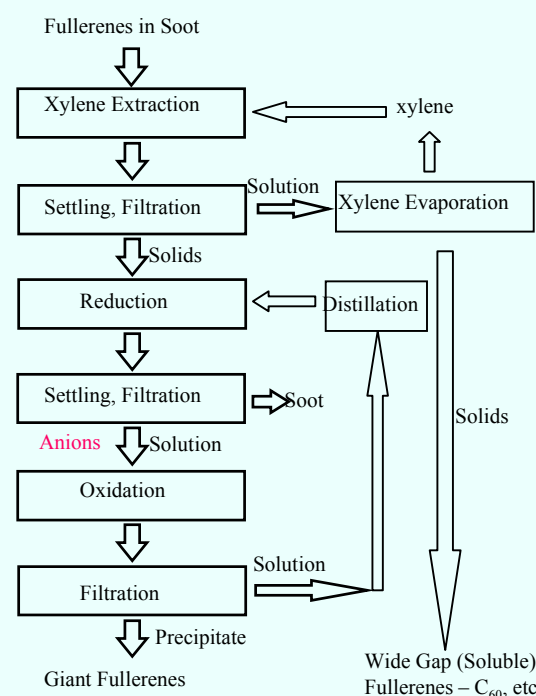
A 55-gallon drum of xylene-extracted combustion soot, still full of giant fullerenes waiting to be recovered!



TOF-MS of recovered giant fullerenes



TOF-MS with 355 nm ionization



Commercialization Planning and Progress

PATENTS: TDA has obtained US patents for the recovery process (6,303,016) and the recovered material (6,517,799). Newer results are also patentable. TDA also has patent applications on the chemical derivatization of small bandgap fullerenes

Patents were obtained based on surreptitious results from an electrochemical process we were developing to recover fullerenes containing a metal atom (an NSF SBIR Phase I). At the time, global production of giant fullerenes was so small that there was no reason to recover them. With the 40 T/yr plant producing tens of tons of giant fullerenes, that has changed.

METHODS: The process technology will be commercialized by licensing it to fullerene producers, and by designing the recovery equipment.

The material (and its chemical derivatives) will be commercialized through sales to companies developing carbon-based products. Sales will be initiated by TDA in the US, and third parties elsewhere.

COST: The price for the recovered “insoluble” fullerenes will be higher than the price of the fullerene soot, based on their value as mixed fullerenes. Thus, this process converts part of the low value product stream into another high value product.

CONTACTS: The primary global producer of fullerenes, to whom we licensed our production technology, meets ~quarterly with the fullerene group at TDA. This project is always on the agenda, as they have invested considerably in developing the production and analytical technologies.

We have also met with their parent company, and are discussing additional investment with them.

MARKETS: The ultimate markets for the recovered material remain speculative; however, what we know so far has suggested applications in catalyst supports, polymers, biomaterials, and antioxidants.