Closed Network Growth of Fullerenes

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Results and Discussion

Enormous advances in nanoscience have been made since the discovery of the fullerenes; however, the formation of these closed-caged nanomaterials still remains a mystery. Here we reveal for the first time that fullerenes self-assemble through a closed network growth (CNG) mechanism by ingestion of atomic carbon and C_2. The growth processes have been elucidated through experiments that probe direct growth of fullerenes upon exposure to carbon vapor, analyzed by state-of-the-art FT-ICR mass spectrometry. The key aspect is to expose gas-phase $^{12}C_{60}$ to amorphous ^{13}C graphite—the resulting isotopic distributions then definitively prove that $^{12}C_{60}$ grows by successive additions of $^{13}C2$ (see **Figure 1**).[1]

Our results shed new light on the fundamental processes that govern self-assembly of carbon networks, and the process of fullerene growth is likely involved in formation of other carbon nanostructures from carbon vapor, such as nanotubes and graphene. Further, the results should be of importance for illuminating astrophysical processes near carbon stars or supernova that result in C_{60} formation throughout the universe.

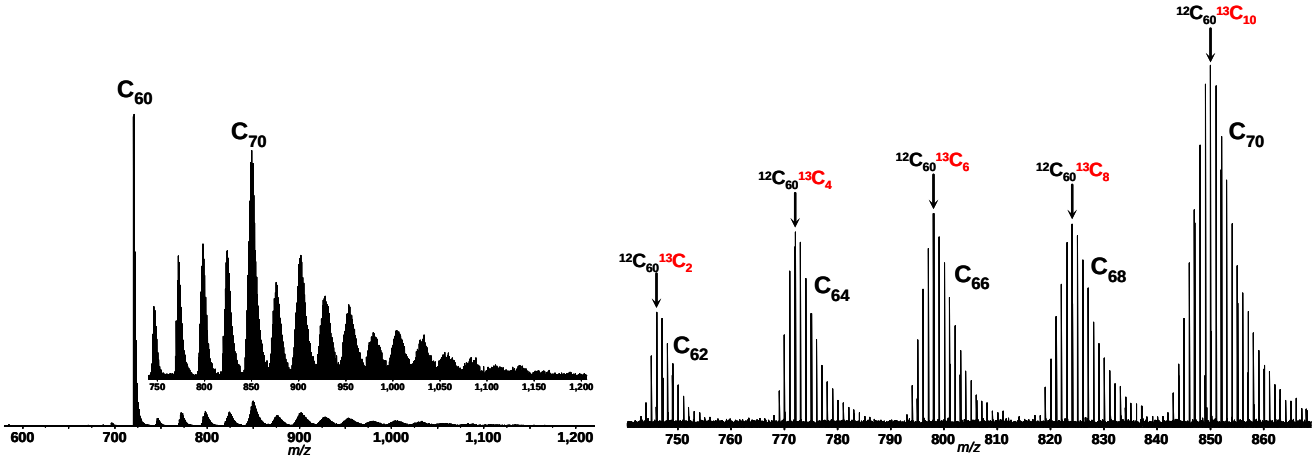

Figure 1. Results of exposure of C_{60} to ^{13}C-enriched carbon vapor. Left: Positive ions generated from a target comprised of amorphous ^{13}C (99% atom ^{13}C) target mixed with C_{60} under the same conditions as in the C_{60}-graphite experiment (Figure 1b), with mass scale expansion of C_{60} illustrating the occurrence of atom exchange events. Right: C_{62}-C_{70} mass region expanded to show growth of C_{60} to larger fullerenes by successive ^{13}C ingestion events.

Acknowledgements

We thank M. A. Duncan for critical information regarding cluster source design, G. T. Blakney for modular ICR data system work, D. McIntosh for machining of custom ion source parts, and V. V. Lobodin for discussion. C.P.E thanks A. Zobelli for discussions. This work was funded by NSF Division of Materials Research through DMR-06-54118 and the Florida State University Research Foundation.

References

[1] Dunk, P. W., *et al.*, Nature Commu, **3**, 855 (2012). doi: 10.1038/ncomms1853.