Dissolution and separation of single-walled carbon nanotubes

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Previous work by NS/CH demonstrated conclusively, using neutron scattering (SANS) techniques, that individual fullerene (C₆₀) molecules become charged and are spontaneously dissolved in metal ammonia ‘electronic liquids’. This observation provided inspiration (initially at an LCN event) for developing a carbon nanotube dissolution and separation technology using similar processes.

Single-walled Carbon Nanotubes (SWNTs) have a series of unique properties that suggest a wide range of applications. However, as produced, they are heterogeneous mixtures of many species; some metallic, some semi-conducting. They are particularly difficult to isolate, and hence purify, due to a strong tendency to ‘bundle’ together. Existing methods work at milligram scales, and are commensurately expensive.

The new approach provides a scalable, bulk technique that avoids the limiting sonication/centrifugation steps associated with other methods, and is very promising for industrial application.

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\text{Single-Walled Carbon Nanotubes (SWNTs)}
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\text{Spontaneous Dissolution of Carbon Nanotubes}
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\begin{align*}
\text{1. Metal dissolved by ammonia} & \quad \text{2. SWNTs reduced by metal-ammonia} \\
\text{3. Charged SWNTs dissolved by metal-ammonia} & \quad \text{4. SWNT metal-ammonia salt dissolved by DMF}
\end{align*}
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\text{Possible applications}
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\text{Roadmap for carbon nanotube based devices (G.S. Duesberg, 12th International Conference on Ultimate Integration on Silicon (ULIS) 2011)}
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\text{Conclusions}
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A new method has been developed to dissolve and separate SWNTs. The availability of large quantities of individualized, purified, undamaged SWNTs will enable further fundamental studies of SWNT phenomena and a wide range of applications. Three patents have been filed on these processes, and have been licensed to Linde who are now developing the technology as part of their Salt-enhanced electrostatic repulsion (SEER) technology portfolio.