Thin films of endohedral fullerenes, conductivity and air sensitivity of $Li@C_{60}$ and $La@C_{82}$

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We present promising results from deposition of and electric measurements on thin layers of the endohedral fullerenes Li@C60 and La@C82. The endohedral fullerenes were inserted into quartz crucibles which could be heated to 450-550^{o}C. The deposition was carried out in ultra high vacuum onto specially designed substrates consisting of SiO_2 with gold connectors on the surface. The connectors were arranged with a spacing of 100 micrometers and the measurements were carried out on fullerene material deposited between the connectors. The deposition of the endohedral fullerenes could be carried out for similar conditions as for C_{60}, but at slightly higher temperatures, probably due to the stronger inter-molecular bonding in the material.

The conductivity of the endohedral fullerene thin layers were measured to be higher than for pristine C_{60}. Preliminary results on thin films exposed to atmosphere suggest that $Li@C_{60}$ is a n-type conductor while $La@C_{82}$ is of p-type. This can be explained by considering the possible electron doping of the cage by the endohedral atoms, however the role of gas diffusion into the films that have been exposed to atmospheric conditions is likely to be of importance and is the subject of ongoing studies.

Sensitivity to air for the endohedral fullerenes is higher than for C_{60}. If the endohedral fullerenes are to be used in electronic applications it is important to understand the influence of air on the stability and conductivity of the thin films. Recent results from laser desorption mass spectrometry experiments [1] show that thin $La@C_{82}$ films, 50-100 nm thick, exposed to air are effected by molecular oxygen on timescales of hours. The oxygen penetrates the thin films reacting with the $La@C_{82}$ to form oxides $La@C_{82}O$ and LaO species as well as empty fullerenes. We will compare the mass spectrometry results with electrical measurements on C_{60}, $Li@C_{60}$ and $La@C_{82}$ performed as a function of gas exposure time. Time-dependent measurements of the conductivity will give information on absorption and reaction rates.

Finally possible solutions for protecting the thin films from atmosphere as well as potential circuits will be proposed and discussed.

[1] A. Lassesson, A. Gromov, M. Jönsson, A. Taninaka, H.Shinohara, E. E. B. Campbell, Int, J. Mass Spec., submitted.