
Synthesis and Characterisation of Novel Materials From Buckminsterfullerene And Magnesium Diboride

Abstract

Until now, concerted efforts have been achieved on investigating the alkali-doped fullerides, A_xC_{60} , whereby the LUMO (t_{1g}) conduction band is filled, as these have been the easiest materials to synthesise. Within this family, the ternary (Na_2AC_{60}) and quaternary ($Na_2AA'C_{60}$) sodium fullerides have presented interesting characteristics with respect to their superconductivity and crystal structure. Na_2CsC_{60} has been found not to follow the trends observed in the other members of this family, more specifically the formation of low-temperature quasi one-dimensional polymers at ambient pressure. Consequently, local probing techniques were employed on pellet and powder samples of Na_2CsC_{60} to investigate whether this polymer phase could be stabilised at ambient pressure.

In contrast, the alkaline earth (AE) and mixed alkali-alkaline earth metal fullerides, whereby the LUMO+1 t_{1u} conduction band is filled, have been poorly studied due to the difficulties encountered in synthesising phase-pure materials. It is already known that certain members of the alkaline earth (Sr_4C_{60} and Ba_4C_{60}) and mixed alkali-barium fullerides ($A_3Ba_3C_{60}$, $A = K, Rb$) are superconducting, but there have been little systematic studies on other stoichiometries. Therefore, the main objective was to try and extend our understanding of these two fulleride families by synthesising and characterising a host of different alkaline and mixed alkali-alkaline stoichiometries: $A_xAE_{6-x}C_{60}$, where $A = K, Rb$ ($1 \leq x \leq 5$) and $AE = Ba, Sr$, and selected AE_xC_{60} , where $AE = Ba, Sr$ ($x = 1, 5$).

Additional studies were also performed on MgB_2 to determine the underlying mechanism of superconductivity in such a relatively simple material. This was achieved through INS studies. Auxiliary experiments were carried out, initially using MgB_2 , utilising C_{60} as a catalyst and I_2 as a transport medium, to investigate the synthesis of nano-type crystal structures. However, it was later discovered that these structures could also be synthesised using solely Mg powder.
