Production of small binary carbon clusters by laser ablation of thin films of derivatised fullerenes

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The distribution of small carbon clusters derived by laser ablation (laser desorption/ionization) of thin films of derivatised fullerenes has been studied. The production of positive and negative ions has been monitored by time-of-flight mass spectrometry. The materials under investigation included the [60]fullerene (C_{60}), hydrogenated and deuterated [60]fullerenes ($C_{60}X_{36}$ where X= H and D), fluorinated [60]fullerenes ($C_{60}F_x$ where x= 46 and 48) and the aza[60]fullereneyl dimer ($(C_{59}N)_2$). Following laser ablation using a nitrogen laser, the efficient formation of small, negatively charged carbon clusters has been observed, while the corresponding positively charged clusters were not formed. Derivatised fullerenes display the co-formation of small binary carbon clusters of the type C_nX^-, where n shows odd/even alternation depending on X which represents the heteroatom initially linked to or networked with the fullerene cage. Although binary carbon clusters C_nX^- were formed where X= H, D and N, the ablation of fluorofullerene targets would not lead to the formation of C_nF^- clusters. Comparison with chloro/fluoroalky-polymers revealed that the lack of C_nF^- is due to the experimental conditions rather than a material property of the target. Instead, the ablation of fluorofullerenes was accompanied by the unexpected formation of metal fluoride anions. The formation mechanism of the binary carbon clusters has been studied by laser fluence-dependent production of C_nD^- ions from $C_{60}D_{36}$, and by the production of C_nP^- ions using a composite C_{60}/P_4 target. The formation of small binary cluster ions is discussed in terms of aggregation reactions versus direct evaporation from the derivatised fullerene.