FLUORESCENCE OF C_{60} IN SOLUTIONS AT ROOM TEMPERATURE

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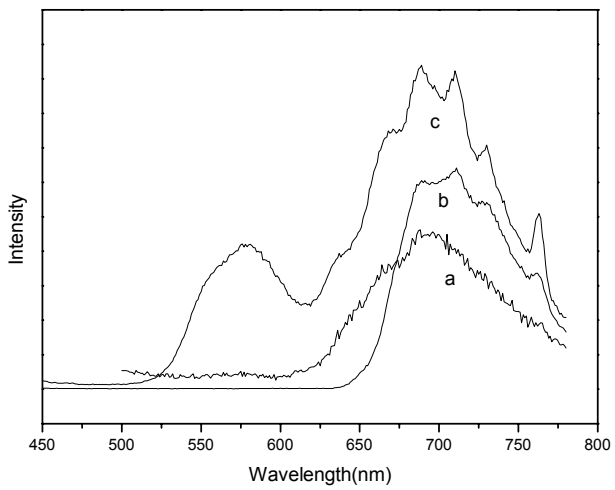
Abstract: Strong, medium and weak fluorescence spectra for C_{60} in different solutions at room temperature are reported for the first time, which indicate that intensity of fluorescence is dependent on the interaction between C_{60} and solvent. It is shown that the solvents of effective electron donors could make a comparatively strong interaction with fullerenes due to the formation of the charge transfer adduct, which could greatly distort the molecular symmetry and lead to the strong fluorescence.

Since the discovery of fullerene, the photophysical properties of C_{60} have been extensively studied [1-3]. However, the low-lying electronic transitions in C_{60} are weakly allowed due to the high icosahedral symmetry of C_{60}, which leads to the small fluorescence radiative. The environmental effects, the rare gas matrix perturbation effect and the low-temperature effect, for example, could relax the selection rules of C_{60} and lead to a high fluorescence radiation rate [4-5]. However, few reports about fluorescence spectra of fullerenes at room-temperature solutions have been reported, and only weak and broad fluorescence spectra for C_{60} were observed [6-7]. At room temperature, in commonly employed solutions such as toluene, benzene, CCl_4 et al, the fullerenes tend to preserve highly molecular symmetry.

It is indicate that intensity of fluorescence for C_{60} is dependent on the interaction between C_{60} and the solvents. The observed fluorescence of C_{60} in room-temperature toluene solution is weak and broad as shown in Fig.1 which demonstrates that the C_{60} only makes a weak interaction with the toluene solution. The recorded medium fluorescence for C_{60} in CS_2 as displayed in Fig.2 indicates that the interaction between C_{60} and CS_2 is slight stronger that that of between C_{60} and toluene. Therefore, the symmery of C_{60} is partly distorted due to this medium interaction. DMSO is an effective electron donor and C_{60} is a potential electron. Charge transfer has occurred between C_{60} and DMSO, which was proved by the electrochemical reduction of C_{60} as shown in fig.3. Therefore, the interaction between C_{60} and DMSO is strong due to the formation of C_{60}- DMSO charge transfer adduct. The fluorescence radiation rate is increased greatly, arising from symmetry lowering and selection rule relaxing of C_{60} induced by the formation of C_{60}- DMSO adduct.

The solvents of effective electrons donors could make a comparatively strong interaction with fullerenes due to the formation of the charge transfer adduct, which could greatly distort the molecular symmetry and lead to the strong fluorescence. Choosing appropriate molecule to form fullerene charge transfer adduct system may offer a new approach for the fabrication of novel fullerene-based luminescent materials.



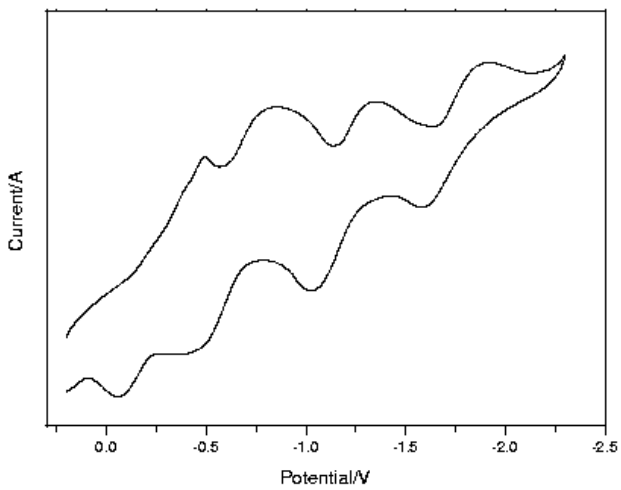


Fig.1 fluorescence spectra for C_{60} at room temperature with excitation at 400nm:
a.weak fluorescence spectrum for C_{60} in toluene solution
b.medium fluorescence spectrum for C_{60} in CS_2 solution
c.strong fluorescence spectrum for C60 in DMSO solution

Fig.2 Cyclic voltammogram for the reduction of C_{60} in DMSO containing 0.1 M (TBA)ClO_4 as a supporting electrolyte at room temperature The counter and working electrodes were Pt, while Ag wire was used as reference electrode. The scan rate was 100 mv/s.

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