SYNTHESIS AND PROPERTIES OF WATER-SOLUBLE FULLERENE DERIVATIVES

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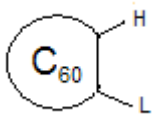
Introduction

The possibility of the use of fullerenes as the biological active compounds in the various aspects has led to the intensive development of the chemistry of functional fullerene derivatives especially after publications on their promising HIV-protease inhibition activity [1,2]

Biological research needs in water-soluble fullerene derivatives with covalent-bonding hydrophilic functional groups (L).

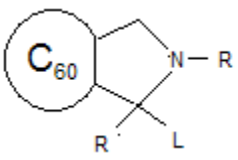
The modern classification of biological active water-soluble fullerenes according to the position of hydrophilic groups shows us two different ways of the chemical functionalization by covalent attachment of solubilizing agents:

1) the direct addition of L-reagent to C_{60} with formation of compound (1) , where L is bonded with carbon of fullerene sphere,



(1)

2) the cycloaddition of L-containing reagent to C_{60} with formation of compound (2) where L is existed in the side-chain of substituted fullerene, for example,



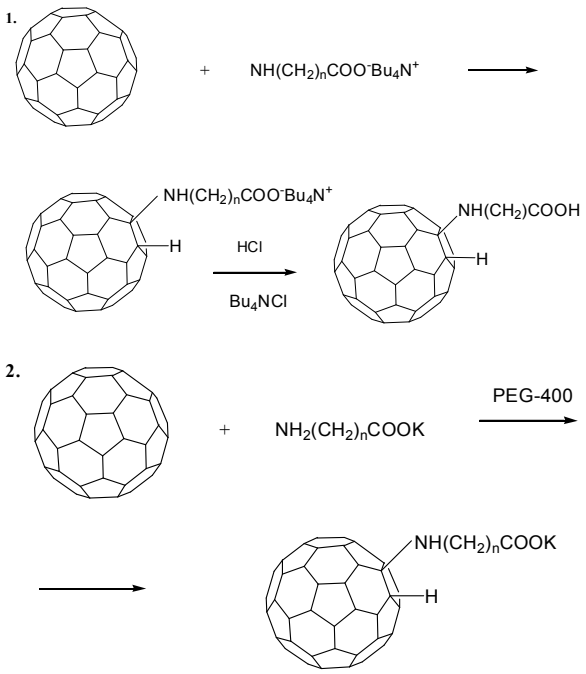
(2)

Results and discussion

In our work we investigated the processes of fullerene amino acides preparation by the direct addition of amino acid derivatives to C_{60}. For the first time these compounds were synthesized by Vol'pin and co-workers [3,4].Their method of preparation has proved unattractive in manufacturing sense.

We have studied some technological aspects of this reaction by the use of the different phase-transfer catalysts and suggested new methods of fullerene amino acids production with quantitative yields (Scheme 1) [5,6] and their purification.

Scheme 1



Sodium salts, $C_{60}(H)NH(CH_2)_nCOONa$ (n=1,2,3,5) are very soluble in water (70 mg ml^{-1} at pH 7). This is the record for water solubility among monofunctionalized fullerenes.

All compounds were characterized by element analysis, IR- and UV-vis spectroscopy methods.

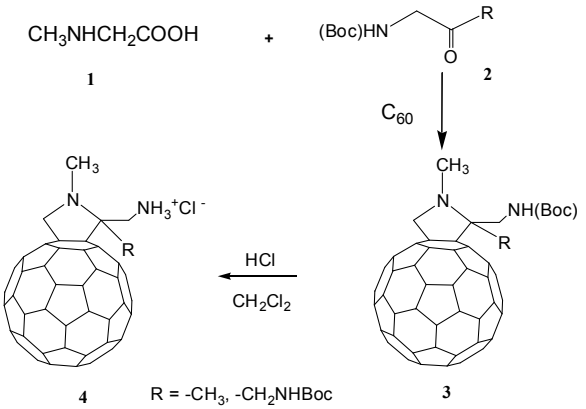
To obtain water-soluble derivatives of type 2, we employed the method of 1,3-dipolar cycloaddition of azomethine ylides [7] via the decarboxilation of immonium salt derived from the condensation of sarcosine with Boc-protected amino ketone(Scheme 2).

In this way, fulleropyrrolidines are obtained with 5-membered ring, containing hydrophilic

ammonium groups (one or two), fused to 6,6 bond on fullerene.

Amino ketones (2) were prepared by oxidation of commercial corresponding amino alcohols.

Scheme 2



Reaction of C_{60} with amino ketone and sarcosine was carried out in toluene at 110°C for 8 hours. The ratio C_{60}:sarcosine:ketone was 1:2:1. The reaction was controlled by TLC. The mixture of addition products was separated by column chromatography on SiO_2.

The main fraction eluted by toluene:chloroform(2:3), which is going directly after unreacted fullerene, contains the product of monoaddition (3). In the case of R=CH_3 we obtain N-methyl-2-(Boc-aminomethyl)-2-methyl [60]Fulleropyrrolidine. Treatment of compound (3) with excess hydrochloric or trifluoroacetic acid gave the corresponding ammonium salts (4).

Compounds (4) with one or two ammonium groups are soluble in DMSO-water and dioxane-water mixtures, suitable for most biological tests in concentration of 10^{-5}M.

All compounds were characterized by elemental analysis, standard spectroscopic methods and electrospray mass spectroscopy (ES-MS).

On the base of our preliminary results we have to say that these methods can be used for functionalization of carbon nanotubes.

Conclusion

The results presented in this report show that both methods of fullerene functionalization can be successfully used for preparation of water-soluble fullerene derivatives.

Acknowlendgement.
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