polyfluorocarbinols with chiral acyl chlorides.[1] However, the stereoselective phosphorylation of such alcohols with chiral, unsymmetrically O-substituted methylphosphonoyl chlorides has not yet been reported.

The replacement of the trimethylsilyl group in the alcohol molecule by a hydrogen atom significantly decreases the stereoselectivity of phosphorylation. Thus, according to the ^{31}P NMR data, the ratio of diastereomers in the phosphonate formed by the phosphorylation of 1-perfluorobutylethanol with chlorophosphonate **2a** is only 40 : 60.

This work was carried out with financial support of the International Scientific Foundation (Grant No. MSF 000).

References

1. D. M. Feigl and H. S. Mosher, *Chem. Comm.*, 1965, **24**, 615.

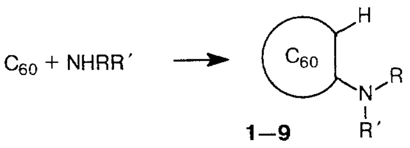
Received April 12, 1994

Addition of amino acids and dipeptides to fullerene C_{60} giving rise to monoadducts

V. S. Romanova, V. A. Tsyryapkin, Yu. I. Lyakhovetsky, Z. N. Parnes,* and M. E. Vol'pin

A. N. Nesmeyanov Institute of Organoelement Compounds, Russian Academy of Sciences,
28 ul. Vavilova, 117813 Moscow, Russian Federation.
Fax: +7 (095) 135 5085

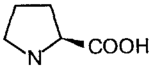
We have developed a general method for the direct addition of amino acids and dipeptides of various structures to fullerene C_{60}. In all cases the addition involves the amino group. The reaction proceeds when the solutions of fullerene and an amino acid (or dipeptide) are mixed at 50—100 °C. The fullerene derivatives of the following amino acids and dipeptides have been obtained: glycine, p-aminobenzoic acid, ω-aminocaproic acid, L-proline, L-alanine, L-alanyl-L-alanine, D,L-alanyl-D,L-alanine, glycyl-L-valine. The adduct of methyl L-alaninate with C_{60} was also prepared.



1—9

R' = H
1: R = CH_2COOH
2: R = C_6H_4COOH
3: R = $(CH_2)_5.COOH$
4: R = L-$CH(CH_3)COOH$
5: R = L-$CH(CH_3)COOCH_3$
6: R = L-$CH(CH_3)CO$-L-$NHCH(CH_3)COOH$
7: R = D,L-$CH(CH_3)CO$-D,L-$NHCH(CH_3)COOH$
8: R = CH_2CO-L-$NHCH[CH(CH_3)_2]$ COOH

9: R'RN =



None of the IR spectra of any of the adducts contained the characteristic absorption bands of the parent fullerene (ν 1429, 1181, 577, and 528 cm^{-1}). On the other hand, they displayed the absorption bands characteristic of amino acid or dipeptide moieties.

The treatment of these fullerene derivatives with CF_3COOH brings about the elimination of the corresponding amino acid or dipeptide. The amino acid analysis of compounds **4** and **8** taken as examples showed that under the conditions indicated above mainly one molecule of amino acid or dipeptide adds to fullerene. The addition of fullerene to amines, halogens, and other reagents mostly yields mixtures of polyadducts[1—3]. Only in the case of methanofullerene was it possible to obtain products containing a single residue of an amino acid (or its derivative)[4—6].

Both specimens of the ester **5** obtained either as disclosed above or by methylation of the acid **4**, display three groups of ion peaks in the high mass region of their EI mass spectra, namely, at *m/z* 823, 824, 825, 826, 827 $[M^+]$, 763, 764, 765, 766, 767 $[M-HCO_2Me^+]$, and 721, 722, 723, 724, 725 $[C_{60}H^+]$.

Adducts **1**, **4**, **6—8** are of special interest because of their solubility in water. The pH of their aqueous solutions is about 4. During electrophoresis in an acetate-pyridine buffer, these derivatives move to the positively charged electrode as single spots. These facts indicate that adducts **1**, **4** and **6—8** are negatively charged in the

Translated from *Izvestiya Akademii Nauk. Seriya Khimicheskaya*, No. 6, pp. 1154—1155, June, 1994.

buffer solution and in every case behave as individual compounds.

This approach provides a beginning for obtaining physoilogically active fullerene derivatives baseds on adducts of fullerene with amino acids or dipeptides.

References

1. A. Hirsch, Q. Li, and F. Wudl, *Ang. Chem. Int. Ed.*, 1991, **30**, 1309.
2. G. A. Olah, I. Bucsi, C. Lambert, R. Aniszfeld, N. J. Trivedi, D. K. Sensharma, and G. K. S. Prakash, *J. Am. Chem. Soc.,* 1991, **113**, 9385.
3. R. Taylor and D. R. M. Walton, *Nature*, 1993, **363,** 685.
4. M. Prato, A. Blanco, M. Maggini, G. Scorrano, C. Toniola, and F. Wudl, *J. Org. Chem.*, 1993, **58**, 5578.
5. A. Sciebe and A. Hirsch, *J. Chem. Soc., Chem. Commun.*, 1994, 335.
6. R. Sijbesma, G. Srdanov, F. Wudl, J. A. Castoro, C. Wilkins, S. H. Friedman, D. L. DeCamp, and G. L. Kenyon, *J. Am. Chem. Soc.*, 1993, **115**, 6510.

Received May 30, 1994