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# A NEW CARBON-PHOSPHOROUS BOND FORMING REACTION AND SYNTHESIS OF AMINOALKYLPHOSPHONIC ACID DERIVATIVES[1]

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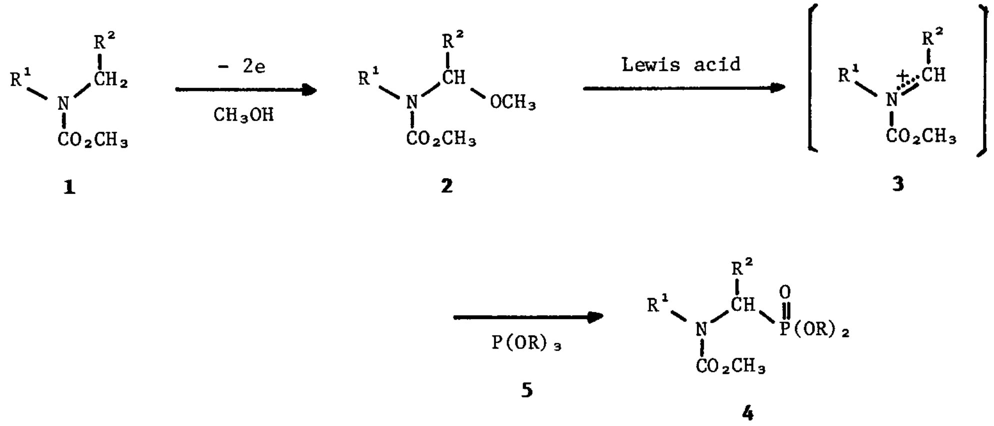
A new carbon-phosphorous bond forming reaction, that is, the reaction of α-methoxyurethanes with trialkyl phosphites in the presence of Lewis acid catalysts was studied on twelve examples.

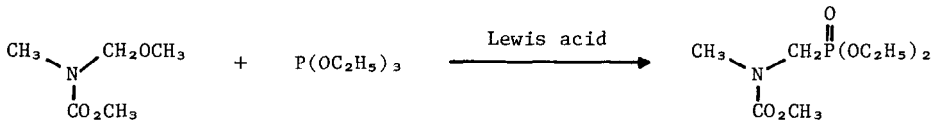
Aminoalkylphosphonic acid derivatives are known to show remarkable activities as pestisides, insecticides, or weedicides.[2] We report herein a new carbon-phosphorous bond forming reaction and the synthesis of aminoalkylphosphonates (**4**) from urethanes (**1**). Scheme I illustrates our method which involves α-methoxyurethanes (**2**)[3] as key intermediates.

Scheme I



Treatment of **2** with Lewis acids presumably generates carbomethoxyiminium ions (**3**) which are trapped by trialkyl phosphites (**5**) to yield **4**. Thus, the reaction of

N-carbomethoxy-α-methoxydimethylamine (**6**) with triethyl phosphite (**7**) was scrutinized to clarify the optimum reaction conditions (eq. 1, Table I).



$$CH_3N(CO_2CH_3)CH_2OCH_3 + P(OC_2H_5)_3 \xrightarrow{\text{Lewis acid}} CH_3N(CO_2CH_3)CH_2P(O)(OC_2H_5)_2 \quad (1$$

**6** **7** **8**

Table I. Reaction of **6** with **7** in the Presence of Lewis Acid Catalysts.[a)]

| Run | Lewis Acid (equiv.) | Solvent | Reaction Time (h) | Yield of **8** (%) |
|---|---|---|---|---|
| 1. | $TiCl_4$ (1) | $CH_2Cl_2$ | 2 | 92 |
| 2. | $ZnCl_2$ (1) | $CH_2Cl_2$ | 6 | 0[b)] |
| 3. | $SnCl_4$ (1) | $CH_2Cl_2$ | 3 | 68 |
| 4. | $BF_3 \bullet OEt_2$ (1) | $CH_2Cl_2$ | 7 | 95 |
| 5. | $BF_3 \bullet OEt_2$ (1) | THF | 5.5 | 78 |
| 6. | $BF_3 \bullet OEt_2$ (1) | ether | 2 | 90 |
| 7. | $BF_3 \bullet OEt_2$ (0.1) | ether | 57 | 52 |

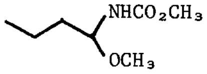
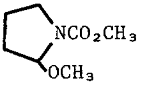
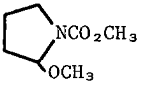
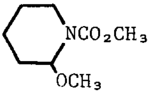
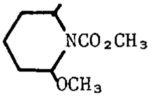
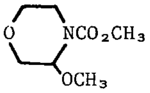
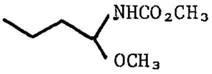
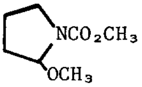
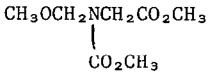
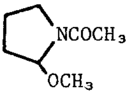
a) After Lewis acid was added at - 20 °C, the reaction mixture was warmed to room temperature, whereas catalyst was added at room temperature in the cases of runs 1 and 2.

b) Starting material was recovered in about 50% yield.

The results shown in Table I indicate that titanium tetrachloride or boron trifluoride etherate is effective as a catalyst.

A typical example is as follows. To a stirred solution of **6** (10 mmol) and **7** (10.7 mmol) in methylene chloride (20 ml) was added dropwise boron trifluoride etherate (10 mmol) at - 20 °C. After addition of the catalyst was completed, the reaction mixture was warmed to

Table II. The Reaction of α-Methoxyurethanes with Trialkyl Phosphites.

| Run | **2** | P(OR)$_3$ | Lewis Acid | Solvent | Reaction Time (h) | Yield of **4** (%) |
|---|---|---|---|---|---|---|
| 1. |  | **7** | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 5 | ~100 |
| 2. |  | **7** | $TiCl_4$ | $CH_2Cl_2$ | 2.5 | 95 |
| 3. |  | **7** | $BF_3$•$OEt_2$ | ether | 2.5 | 98 |
| 4. |  | **7** | $TiCl_4$ | $CH_2Cl_2$ | 4.5 | 93 |
| 5. |  | **7** | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 4.5 | 88 |
| 6. |  | **7** | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 2 | 81 |
| 7. | **6** | $P(OCH_3)_3$ | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 5 | ~100 |
| 8. |  | $P(OCH_3)_3$ | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 3.5 | 97 |
| 9. |  | $P(OCH_3)_3$ | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 3.5 | ~100 |
| 10. | **6** | $P(OPh)_3$ | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 18 | 56 |
| 11. |  $CH_3OCH_2\underset{\begin{array}{c}\vert\\CO_2CH_3\end{array}}{N}CH_2CO_2CH_3$ | **7** | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 3 | 81 |
| 12. |  * (**9**) | **7** | $BF_3$•$OEt_2$ | $CH_2Cl_2$ | 5 | 70 |

* The reaction of acetamide (**9**) with **7** gave the similar result to that of **2**.

room temperature and stirred for 7 h. Usual working up[4] of the reaction mixture followed by distillation gave **8** in a 95% yield. All other results are summarized in Table II.[5]

As shown in Table II, trimethyl phosphite and triphenyl phosphite also react with **2**, though triphenyl phosphite is less reactive than the other two phosphites.

This new carbon-phosphorous bond forming reaction possesses high potentiality in synthesis of aminoalkylphosphonic acid derivatives, since dialkoxyphosphinyl group can be introduced in two steps to a variety of aliphatic amines at the position α to nitrogen atom.

## References and Notes

1. Electroorganic Chemistry. 53.
2. J. Emsley and D. Hall, "The Chemistry of Phosphorous", Harper and Row, London, 1976.
3. T. Shono, Y. Matsumura, and H. Hamaguchi, *J. Am. Chem. Soc.*, **97**, 4264 (1975).
4. The reaction mixture was poured into water, extracted with methylene chloride, and drie over magnesium sulfate, successively. In the case of run 3 of Table I, the organic layer was washed with aqueous sodium bicarbonate.
5. All the products gave the satisfactory data in spectroscopic and elemental analyses.

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