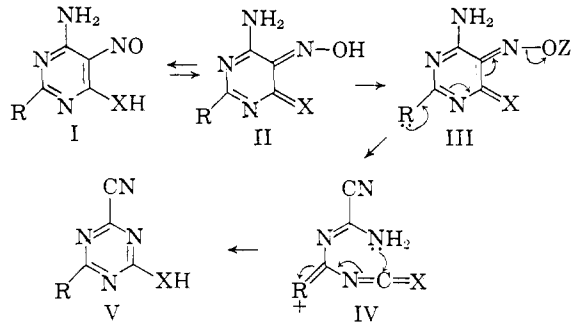
m.p. > 350° (V, R = NH_2, X = O) upon heating for a few minutes with trifluoroacetic anhydride.

We believe that these transformations are initiated by esterification of the 5-nitrosopyrimidine in its oxime form (II) to give III (Z = $SO_2C_6H_5$, $COCH_3$, $COCF_3$). Elimination of ZO^- with cleavage of the C_4–C_5 bond then yields the open-chain intermediate IV in a reaction closely related to the "fragmentations" discussed by Grob.[6] Recyclization gives the observed products (V). This interpretation is consistent with the observation that the transformation is facilitated markedly by the introduction of electron-releasing substituents (*e.g.*, $N(CH_3)_2$, SCH_3) in the 2-position of the pyrimidine ring.



The reaction appears to be general for 5-nitroso-6-aminopyrimidines and represents a convenient method for the preparation of cyano-*s*-triazines.

(6) C. A. Grob in "Theoretical Organic Chemistry," Kekulé Symposium, Butterworths Scientific Publications, London, 1959, p. 114.

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COMPLEX CARBONYL HYDRIDES OF OSMIUM AND RUTHENIUM

Sir:

We have reported recently the discovery and some properties of monohalogeno complexes of osmium and ruthenium with triphenylphosphine and triphenylarsine which were obtained from the simple system of metal salt [$(NH_4)_2OsX_6$, RuX_3], ligand and alcohol (2-methoxyethanol or ethylene glycol, 120–190°).[1,2] Based on analytical and conductivity data, these compounds were formulated as containing univalent metal, $[MXL_3]$ (M = Os, Ru; X = Cl, Br; L = Ph_3P, Ph_3As). Thus, in the absence of a direct evidence to the contrary, decomposition of solvent alcohol *and* coördination of its fragments to the metal were not considered, following the theretofore accepted assumption in the preparative coördination chemistry. Since then, however, it has been demonstrated that metal-hydrido complexes may be formed readily by reaction with alcohol in similar systems.[3] And Chatt and Shaw[4] have reported to have obtained also carbonyl complexes from a related environment (ethanol + KOH), citing as evidence strong bands near 1900 cm.$^{-1}$ in the infrared spectrum which are attributed to $\nu_{C=O}$. In view of these observations, and particularly since we have found similar strong absorptions at 1800–2100 cm.$^{-1}$ in the spectra of a number of mono-, di- and trihalogeno complexes of osmium and ruthenium, some of which, as we now find, are formed even at *25°* (including monohalides),[5] we have undertaken a study of these reactions by using radiocarbon and deuterated alcohols as solvents.

According to the evidence obtained from these experiments, summarized below, we now wish to reformulate the monohalogeno complexes of Os and Ru as containing also hydrido and carbonyl groups, $[MHX(CO)L_3]$ (*cf.* ref. 4).

TABLE I

Compound	Infrared spectrum (cm.$^{-1}$)[a] ν_{M-H}	ν_{M-D}	$\nu_{C=O}$	Oxygen, % Found	Calcd.	No. of ^{14}C/f.w. of compd.
$[RuHCl(CO)(Ph_3P)_3]$	2020	1457	1916 1900	1.8	1.7	1.02
$[OsHCl(CO)(Ph_3P)_3]$	2100	1505	1898 1884	1.6	1.5	1.05
$[OsHBr(CO)(Ph_3P)_3]$	2105	1509	1902 1886	1.4	1.5	0.85

[a] ±5 cm.$^{-1}$; halocarbon mull. [b] ν_{M-H}/ν_{M-D} = 1.39 to 1.40; calcd., 1.41.

The presence of a metal–hydrogen bond and the assignment of ν_{M-H} are indicated by the isotopic shift in the infrared spectrum. The metal deuterides (or hydride–deuteride mixtures) were prepared by either refluxing a suspension of the complex in C_2H_5OD, or directly from the metal salt, Ph_3P and deuterium-enriched 2-methoxyethanol (120°) or ethylene glycol (180°).

The unusual reaction of Os and Ru halides with alcohols leading to carbonyl complexes was studied by synthesizing the compounds in the usual manner except using ^{14}C-ethylene glycol as solvent (190°). The products, after being washed extensively (methanol) and dried (vacuum), were dissolved in toluene scintillator solution and the activity counted. The absolute activity of the samples was compared with that of the starting ^{14}C-ethylene glycol by adding standard ^{14}C-toluene to the samples.

The results (Table I) indicate that one carbon atom of the ethylene glycol is incorporated per formula weight of the complex. The analytical data do not, except for oxygen, readily distinguish between the previous and present formulation of these complexes. Repeated oxygen analyses have now established that M/O = 1. According to the infrared spectra this oxygen is not associated with either —OH or triphenylphosphine oxide (possible forms of oxygen that have been observed to be present in other compounds obtained from the same systems), which, altogether, appears to confirm the suggested composition and the assignment of $\nu_{C=O}$.

The authors are indebted to Dr. R. H. Schuler of the Radiation Research Laboratories of this Institute for valuable suggestions and help in carrying out counting experiments, for supplying radiocarbon alcohols and making equipment available in his laboratories. They also wish to thank

(1) L. Vaska, *Z. Naturforschg.*, **15b**, 56 (1960).
(2) L. Vaska and E. M. Sloane, *J. Am. Chem. Soc.*, **82**, 1263 (1960).
(3) L. Vaska, *ibid.*, **83**, in press (1961).
(4) J. Chatt and B. L. Shaw, *Chem. and Ind.*, 931 (1960).

Drs. R. G. Hayter and R. D. Feltham for discussions and their interest in this work.

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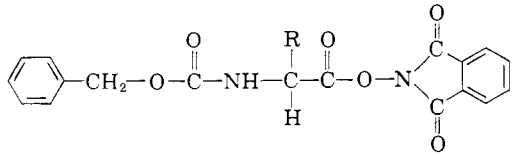
A NOVEL ACTIVATED ESTER IN PEPTIDE SYNTHESES

Sir:

Bodanszky and du Vigneaud[1,2] have introduced the *p*-nitrophenylesters of N-carbobenzoxyamino acids for the synthesis of oligopeptides. The advantage of this method is obvious and has been discussed thoroughly by these authors. In extending this conception it seemed of interest to us to study activated esters of the general type (I) for their properties as N-acylating agents.



I, R = -H

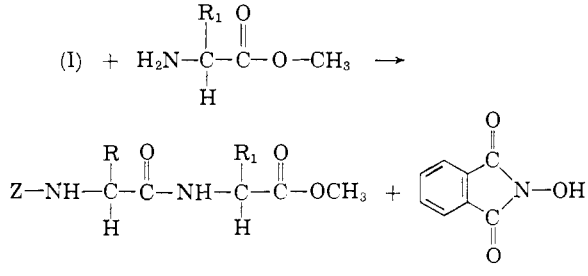
= $-CH_2-CH(CH_3)_2$ (L)

= $-CH_2-C_6H_5$ (D, L and L)

= $-CH_2-S-CH_2-C_6H_5$ (L)

and Z-L-prolyl-hydroxyphthalimide ester

These activated esters (I) are synthesized readily from N-carbobenzoxyamino acids and N-hydroxyphthalimide[5,6] in the presence of dicyclohexylcarbodiimide.[3] They crystallize with ease from ethanol or carbon tetrachloride and have been obtained in yields of 40–80% of the theory depending on the amino acid employed. In the presence of another amino acid ester, the active esters (I) react within seconds, at 0° and in quantitative fashion with formation of a protected dipeptide according to the equation



The N-hydroxyphthalimide can be removed completely by shaking the reaction mixture with an aqueous solution of sodium bicarbonate in which the anion of the former is readily soluble with formation of a brilliant red coloration. With this method Z-L-leucyl-L-leucine-methyl ester and Z-glycyl-D,L-phenylalanine methyl ester have been synthesized in excellent yield and purity.

(1) M. Bodanszky, *Nature*, **183**, 1324 (1959).
(2) M. Bodanszky and V. du Vigneaud, *J. Am. Chem. Soc.*, **81**, 5688 (1959).
(3) D. F. Elliot and D. W. Russell, *Biochem. J.*, **66**, 49P (1957).

The tripeptide Z-glycyl-L-phenylalanylglycine methyl ester, synthesized by stepwise addition of glycine-ethyl ester to Z-L-phenylalanylhydroxyphthalimide ester, then decarbobenzoxylation and a new addition of Z-glycylhydroxyphthalimide ester, showed no trace of racemization in the test according to Anderson and Callahan.[4]

For the preparation of N-hydroxyphthalimide 1 mole of hydroxylamine hydrochloride and 2 moles of triethylamine are heated in 500 ml. of absolute ethanol until complete dissolution has occurred. To the hot solution 1 mole of N-carboethoxyphthalimide[5,6] is added at once with mechanical stirring. The solution changes to a deep red, owing to the formation of the triethylammonium salt of N-hydroxyphthalimide.

After immediate cooling to room temperature the solution is poured into 3 l. of acidified water. The product crystallizes spontaneously in form of fine, nearly colorless needles. After filtration, washing with water and drying over P_2O_5 *in vacuo* the product is suitable for the preparation of activated esters; m.p. 230°; yield 70% (of theoretical).

The substance otherwise is identical with the previously described compound.[7,8] Details of this procedure will be published shortly.

Acknowledgment.—We are indebted to Professor F. Zilliken for valuable discussions.

(4) G. W. Anderson and F. M. Callahan, *J. Am. Chem. Soc.*, **80**, 2902 (1958).
(5) G. H. L. Nefkens, *Nature*, **185**, 309 (1960).
(6) G. H. L. Nefkens, G. I. Tesser and R. J. F. Nivard, *Rec. trav. chim.*, **79**, 688 (1960).
(7) L. Cohn, *Ann.*, **205**, 295 (1880).
(8) N. I. Putokhin, *J. Russ. Phys. Chem. Soc.*, **62**, 2203 (1930).

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PEPTIDE SYNTHESIS VIA OXIDATION OF HYDRAZIDES

Sir:

Recently it was observed[1] that γ-glutamylhydrazide reacts with two equivalents of N-bromosuccinimide (NBS) to give pyrrolidonecarboxylic acid and nitrogen in quantitative yield. Accordingly, it appeared that this procedure under proper conditions might serve as a new method for peptide synthesis.

Z.Gly.$NHNH_2$ and Gly.$OBz(NO_2)$.HBr[2] were coupled instantaneously upon addition of two equivalents of NBS. The reaction was carried out in an ice-bath in the presence of three equivalents of triethylamine (TEA) using tetrahydrofuran (THF) as solvent. Z.Gly-Gly.$OBz(NO_2)$ was isolated after two minutes from the reaction mixture by addition of about 5 volumes of water, and recrystallized from ethanol–water, m.p. 99°, yield 86% (*Anal.* Calcd. for $C_{18}H_{18}O_7N_3$: C, 56.85; H, 4.77; N, 10.47. Found: C, 57.07; H, 4.95; N, 10.51). The over-all reaction may be summarized as shown

(1) P. M. Gallop, S. Seifter and C. Franzblau, unpublished results.
(2) Z, benzyloxycarbonyl; $OBz(NO_2)$, *p*-nitrobenzyl ester.