Translated from *Uspekhi Khimii*, **46**, 507 - 529 (1977) U.D.C. 546.287

Latest Research on the Hydrosilylation Reaction

E.Lukevics

The latest (1964-1974) literature data on the hydrosilylation reaction are surveyed and the results of studies on hydrosilylation, the possibility of using new catalysts, new applications, and the commonest side reactions are considered. The bibliography includes 428 references.

CONTENTS

I. Introduction 264
II. New catalysts 264
III. The properties of hydrosilylation 266
IV. New applications of hydrosilylation 268
V. Anomalous and side reactions 269

I. INTRODUCTION

During recent years, the hydrosilylation reaction has become the most popular method for obtaining a wide variety of carbofunctional organosilicon monomers. Thus, whereas during the first decade after its discovery (in 1947) approximately 150 publications with 500 examples of the reaction were devoted to hydrosilylation, during the last decade after the publication of the first monograph on hydrosilylation[1] (1964) the number of relevant publications already exceeded 1500. They describe approximately 10 000 instances of the application of the hydrosilylation reaction not only in the synthesis of monomers, but also in the formation of a new type of organosilicon polymers (the polyaddition reaction).

Attempts at a systematic arrangement of the enormous amount of experimental data on the hydrosilylation of unsaturated compounds (up to 1967) and on the employment of the hydrosilylation reaction for the synthesis of carbofunctional organosilanes (up to 1971) were undertaken in two major reviews[2,3]. Individual problems of hydrosilylation have been considered also in a number of other reviews[4-21].

This review surveys the results of research on hydrosilylation, gives a systematic account of data on the utilisation of new catalysts, and examines new possibilities for the application of the hydrosilylation reaction on the basis of data published up to 1975.

II. NEW CATALYSTS

Chloroplatinic acid is the catalyst most frequently used for the hydrosilylation of the C=C double bond and the C≡C triple bond. It is usually employed in the form of a solution in isopropyl alcohol. However, in many instances, in order to avoid side reactions[22-32], shorten the induction period[33], and increase the yield of the isomer with a terminal silyl group[13,34], a solution of $H_2PtCl_6.6H_2O$ in tetrahydrofuran has been used. In some cases the catalyst was prepared in methanol[35], ethanol[36-39], butanol[40-46], 2-methyl-2-propanol[47,48], octanol[49-60], a 2-propanol–benzene mixture[61], cyclohexanone[62], dimethyl ether of ethylene glycol[63-67] or diethylene glycol[68-69], ethyl acetate[70], methyl benzoate[71,72], and dimethyl phthalate[73-77]. An active catalyst was obtained by treating $H_2PtCl_6.6H_2O$ with dichloromethylsilane at 20°C for 12 h.[78,79]. Chloroplatinic acid has also been used together with a buffer solution of a strong acid in water[80,81].

Since chloroplatinic acid may form a complex with the initial ethylenic or acetylenic compound, complexes of platinum derivatives with various unsaturated compounds, namely ethylene[82-91], cyclohexene[82,85,92-97], styrene and its derivatives[98-103], vinylsiloxanes[88,104-114], vinylpyridine[115,116], ethylene and pyridine[117-119], ethylene and phosphines[120,121], and alkylethylenes[21,122,123], as well as complexes with cyclopropane[124-128], ketones[62,129-131], nitriles[132-134], phosphines[132,135-142], phosphines on polymeric carriers[143,144], dialkyl sulphides[145-148], and sulphoxides[149] have been proposed as hydrosilylation catalysts.

The use of bivalent and quadrivalent platinum complexes of pyridine has also been described[132,150,151]. Sometimes amines (butylamine[152], tributylamine[153], and triethylenediamine[154,155]) were added to chloroplatinic acid in order to increase the yield of the reaction product, but in other instances the addition of amines inhibited hydrosilylation[21,22,33,156,157]. The addition of a small amount of amines can alter appreciably the mode of hydrosilylation (towards the formation of the β-isomer in the case of styrene[132]). Two-centre Me_3PtI complexes[158] with pyridine[159,160] and hexamethyldiplatinum have also been used[158].

Platinum complexes on inorganic[144] and organic[143,161-164] polymeric carriers have begun to be employed on a wide scale recently. Polymeric platinum chelates with di-(8-hydroxy-5-quinolinyl)methane have also been proposed as hydrosilylation catalysts[165]. A solution of chloro-osmic acid in ethanol catalyses the addition of dichloromethylsilane to vinylsilanes, like chloroplatinic acid[166,167]. Palladium complexes, for example $(Ph_3P)_4Pd$,[140,168-176] $(Ph_3P)_2PdCl_2$,[144,168,177] $(PhCN)_2PdCl_2$,[177-180] $(Ph_3P)_2.(p\text{-quinone})Pd$,[140] $(Ph_3P)_2.$ .maleic anhydride.Pd,[140,181] and palladium complexes of diorganophosphinoalkylpolysiloxanes[144,182] proved to be effective catalysts of the hydrosilylation of alkenes and polyenes. The palladium(II) complexes of menthyldiphenylphosphine and neomenthyldiphenylphosphine have been used for the asymmetric hydrosilylation of styrene and cyclic conjugated dienes[178].

A wide variety of rhodium(I) complexes proved in many instances to be not inferior to platinum compounds as regards catalytic activity. Complexes of triphenylphosphine $[(Ph_3P)_3RhCl]$ [31,144,183-196] and diphenylphosphine $[(Ph_2PH)_3RhCl]$, [197] the triorganophosphinerhodium carbonyls $(Ph_3P)_2(CO)RhCl$, [187,188] $(Ph_3P)_3(CO)RhH$, [185,196] and $(Et_3P)_2(CO)RhCl$, [187] the rhodium carbonyl $[RhCl(CO)_2]_2$, [185,187] the olefin complex $[(C_2H_4)_2RhCl]_2$, [86,198] the bisdimethylglyoximato-complex $[(Ph_3P)(C_4H_7N_2O_2)Rh]_2$, [199-203] and certain others[204-206] have been proposed. The activity of the rhodium catalysts in the reaction of trichlorosilanes with hexene diminishes in the sequence[187]

$$[RhCl(CO)_2]_2 > (Ph_3P)_2(CO)RhCl > (Ph_3P)_3RhCl > (Et_3P)_2(CO)RhCl .$$

$(Ph_3P)_3RhCl$ in methylene chloride is less active in the reaction of dimethylphenylsilane with ethylene than $H_2PtCl_6.6H_2O$ in tetrahydrofuran[31]. The latter is also less sensitive to the effect of substituents in the benzene rings of aryldimethylsilanes. It has been shown that $[(C_2H_4)_2.RhCl]_2$ is a more active catalyst than $(Ph_3P)_3RhCl$. [198] Its use for the hydrosilylation of *cis*- and *trans*-hept-2-enes with trichlorosilane leads to trichloro-n-heptylsilane (as for H_2PtCl_6). [198]

The rhodium complexes of phosphines have been used successfully also for the hydrosilylation of C=O [195,207-219] and C=N [220-222] bonds. The asymmetric hydrosilylation of carbonyl compounds has been carried out in the presence of complexes with chiral ligands[142,208-210,213,215,218,219,223].

Rhodium complexes on polymeric carriers have been prepared recently[143,144,224-228] and it has been observed that these complexes catalyse effectively the addition of trialkyl- and trialkoxy-silanes to alkenes and of trialkoxysilanes to vinyl ethers and only slightly the addition of trichlorosilane to alkenes. On the other hand, the analogous platinum complexes catalyse the reactions with trichlorosilane more effectively than those with triethylsilane[143]. Ruthenium complexes have also been used for hydrosilylation[196,229,230], but iridium complexes of the type $(Ph_3P)_2(CO)IrCl$ have proved to be inactive[188].

New possibilities in the hydrosilylation reaction arose following the application of nickel complexes[132,169,170,231-243]. Thus, whereas the reaction of trichlorosilane with styrene in the presence of H_2PtCl_6 leads to the formation of a mixture of α- and β-adducts with the β-isomer predominating (35 : 65), when $(Ph_3P)_2NiCl_2$ is used as the catalyst the main product is the α-isomer (80 : 20), [231] while the use of π-$C_5H_5(CO)Ni$ [240] and $Ni(CO)_4 + Ph_3P$ (1 : 2) [132] yields exclusively the α-isomer. The yield of hydrosilylation products, which usually does not exceed 20% in the presence of the phosphonickel catalyst, can be raised to 75% by employing CuCl as the cocatalyst. The mixture then contains up to 95% of the α-isomer[213].

Acrylonitrile, methyl acrylate, vinyl acetate, cyclohexa-1,4-diene, and isoprene give rise to normal addition products only, even in the presence of dichloro[1,1-bis-(dimethylphosphino)ferrocene]nickel(II), which caused a marked disproportionation of the silane (83% of chloromethyloctylsilane) in the addition of dichloromethylsilane to oct-1-ene[234]. The $NiCl_2$ complex with 1,2-bis(dimethylphosphino)-*o*-carborane [(Dmpc).$NiCl_2$], containing an electron-accepting ligand, promotes the formation of α- and β-isomers even in reactions with alk-1-enes[237]. For example, when propene interacted with trichlorosilane at 120°C for 20 h in the presence of (Dmpc).$NiCl_2$ (10^{-3} mole per mole of the olefin), the addition product consisting of dichloroisopropylmethylsilane and dichloromethyl-n-propylsilane in proportions of 41 : 59 was formed in 40% yield[237]:

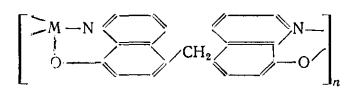
$$CH_3CH{=}CH_2 + MeSiHCl_2 \rightarrow \underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH_3CHSiCl_2Me}} + CH_3CH_2CH_2SiCl_2Me \ .$$

The reactions involving pent-2-ene and hex-2-ene result in the formation, together with n-alkyl derivatives (20–50%), also of the products of the addition of the hydrosilane to the double bonds of the non-isomerised alk-2-enes[237].

Using *trans*-$[(+)$-(R)-$(PhCH_2)MePhP]_2NiCl_2$, it was possible to achieve the asymmetric hydrosilylation of α-methylstyrene with dichloromethylsilane, which gave 31% of the β-adduct with a 17.6% enantiomeric excess of the *R*-isomer[238].

Ziegler systems of the type $M(acac)_n$–$AlEt_3$ (M = Ni, Co, or Fe) catalyse the addition of trialkyl- and trialkoxysilanes to 1,3-dienes, promoting the formation of 1,4-adducts. The nickel catalysts are the most active among them[239,244].

The catalytic activity of the polymeric chelates of Group VIII metals with di-(8-hydroxy-5-quinolinyl)methane



is determined by the nature of the metal M. For example, the platinum chelate is active in the reaction of trichlorosilane with hex-1-ene (2 h, 100°C, yield 70%). When M = Ni, the yield of trichlorohexylsilane was only 5%, while the rhodium and palladium chelates do not catalyse the reaction. In the reaction with triethoxysilane, the rhodium chelate (92%) proved to be more active than the platinum chelate (85%), while the palladium and nickel chelates showed virtually no catalytic activity[165]. The nature of the metal determines also the ratio of the α- and β-isomers in the reaction of trichlorosilane with styrene: 95% β for M = Rh, 92% β for M = Pt, and 19% α for M = Pd. [165] The reaction of trichlorosilane with buta-1,3-diene in the presence of the palladium chelate results in the formation of 86% of *cis*-1-trichlorosilylbut-2-ene, while in the presence of the platinum chelate a mixture of four products is formed: *cis*-1-trichlorosilylbut-2-ene (16%), *trans*-1-trichlorosilylbut-2-ene (37%), 1-trichlorosilylbut-3-ene (14%), and 1,4-bis(trichlorosilyl)butane (4%). [165]

$Co_2(CO)_8$, [31,185,193,245-247] $HCo(CO)_4$, [248-250] $(Ph_3P)_3CoH_3$, [251] and other cobalt complexes [245,251,252] have been used for the hydrosilylation of alkenes. Dicobalt octacarbonyl also catalysed the α-addition of chlorodimethylsilane to acrylonitrile[185].

The hydrosilylation of α-alkenes[253-256] and acetylenes[256] is also catalysed by $Fe(CO)_5$. Here the initial alkene reacts in four ways: it interacts with the hydrosilane to form both the addition product and the dehydrocondensation product, isomerises, and is hydrogenated[254]:

$$PrCH{=}CH_2 + MeEt_2SiH \xrightarrow{Fe(CO)_5} MeEt_2SiCH_2CH_2Pr + MeEt_2SiCH{=}CHPr + C_5H_{12} + \text{isomeric pentenes.}$$

Dimanganese decacarbonyl[245] and cyclopentadienylmanganese tricarbonyl[257,258] have also been used as hydrosilylation catalysts.

Copper compounds [Cu_2O, Cu_2Cl_2, and $Cu(acac)_2$] in mixtures with organic cyanides are effective catalysts of

the hydrosilylation of acrylonitrile, promoting the formation of the β-adduct in the reaction with both trichlorosilane (70–78%) and dichloromethylsilane (80%).[259]

The addition of hydrosilanes of different olefins in high yields is initiated by γ-radiation[260-267] in view of the absence of side reactions, which are unavoidable in thermal addition[1,268].

Peroxides have been rarely used in recent years for the initiation of the hydrosilylation of the C=C bond[269-272], although a new catalyst has in fact been proposed, namely dicyclohexyl peroxycarbonate[273]. At the same time, the hydrosilylation of the N=N bond was actually achieved for the first time in the presence of a peroxide[274].

It has also been shown that the use of peroxy-catalysts in conjunction with ultraviolet irradiation permits the hydrosilylation of α-alkenes[275-278] and cyclohexene[275] with trichlorosilane at a low temperature (0–20°C). The yields of the addition products reach 80–95%. Dichloromethylsilane also reacts fairly satisfactorily with alk-1-enes, while triethylsilane, triphenylsilane, triethoxysilane, and 3*H*-heptamethyltrisiloxane do not react under these conditions (30–40°C, 38 h).[277] The use of bis-(trimethylsilyl)mercury as the sensitiser accelerates the addition of trichlorosilane to oct-1-ene under the influence of ultraviolet irradiation by a factor greater than two relative to the reaction initiated by t-butyl peroxide[275]. The photochemical hydrosilylation of 1,3-dienes by trialkylsilanes takes place in the 1,4-positions and is catalysed by chromium hexacarbonyl[279].

III. THE PROPERTIES OF HYDROSILYLATION

1. The Reactivity of Hydrosilanes

Kinetic studies on the hydrosilylation of hept-1-ene in the presence of $H_2PtCl_6.6H_2O$ showed that the rate of reaction decreases with increase of electron density at the hydrogen atom[31]:

$$\underset{3.00}{HSiCl_3} > \underset{2.64}{EtSiHCl_2} > \underset{1.94}{Et_2SiHCl} > \underset{1}{Et_3SiH}$$

However, the changes are not additive and are not correlated with the inductive Taft constants σ*, so that the differences between the reactivities in this series of hydrosilanes cannot be accounted for solely by the inductive effects of the substituents.

The rate of hydrosilylation of hex-1-ene increases on passing from tripropylsilane to diethoxypropylsilane[31]:

$$\underset{15.26}{Pr(EtO)_2SiH} > \underset{4.33}{Pr_2EtOSiH} > \underset{1}{Pr_3SiH}$$

When the reaction is carried out in the presence of $H_2PtCl_6.6H_2O$, triethoxysilane proves to be less reactive than diethoxypropylsilane[31]; on the other hand, in the presence of $(Ph_3P)_3RhCl$ or $Co_2(CO)_8$ triethoxysilane proves to be more reactive[193]:

	$(EtO)_3SiH$	$Pr(EtO)_2SiH$	$Pr_2EtOSiH$	Pr_3SiH
$(Ph_3P)_3RhCl$	42.8	28.4	5.4	1
$Co_2(CO)_8$	119.0	59.5	27.5	1

When rhodium complexes with phosphine ligands on a modified silica gel are used in the reactions with hexene, heptene, and ethyl vinyl ether, triethoxysilane also exhibits an enhanced reactivity:

$$(EtO)_3SiH > Et_3SiH > HSiCl_3 .$$

Trichlorosilane proved to be most reactive in the reaction of decene in the presence of the analogous platinum catalyst[144]:

$$HSiCl_3 > (EtO)_3SiH > Et_3SiH .$$

The increase of the rate of reaction with decrease of electron density in the Si–H bond has also been observed in the addition of aryldimethylsilanes $p\text{-}XC_6H_4(CH_3)_2SiH$ to ethylene. The rate of reaction in the presence of $(Ph_3P)_3RhCl$ increases on passing from dimethyl-*p*-methoxy-, to dimethyl-*p*-chloro-phenylsilane[31]:

$$\underset{1.35}{Cl} > \underset{1}{H} > \underset{0.78}{MeO} .$$

It is noteworthy that, in hydrosilylation in the presence of platinum, rhodium, and ruthenium complexes, the rate of reaction depends also on the stability of the complex of the catalyst and the hydrosilane[280], which can lead to reactivity series inconsistent with the corresponding series based on the variation of reactivity established in the reactions involving H_2PtCl_6. For example, the yield of the product of the hydrosilylation of hexene in the presence of $(Ph_3P)_3RhCl$ decreases on passing from Ph_3SiH (100%) to Et_3SiH (60%) and $HSiCl_3$ (8%),[188]. The decrease of the yield of the hydrosilylation product with increase of the number of chlorine atoms has also been observed for chloroethylhydrosilanes[198], which is consistent with the series based on the increase of the stability of the complexes $(Ph_3P)_2RhH(SiCl_nR_{3-n})X$.[188] However, when a competition addition reaction was carried out, hydrosilanes with a greater number of chlorine atoms proved to be more reactive both in the presence of $(Ph_3P)_3RhCl$ [193] and $[(C_2H_4)_2RhCl]_2$.[198]

Hydrosilylation under the influence of dinuclear platinum complexes of styrene proceeds as a two-stage process owing to the conversion of the initial compounds into complexes with a much lower catalytic activity. The rates of cleavage of the olefinic complexes and of addition in the second stage of the reaction increase with decrease of the strength of the Si–H bond[98]:

$$MeSiHCl_2 > Me_2SiHCl > Me_3SiH .$$

Other reactivity series have also been obtained for hydrosilanes, namely for the hydrosilylation of α-alkenes in the presence of H_2PtCl_6:[281]

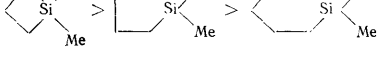
$$\underset{2.75}{PrSiHCl_2} > \underset{1.80}{EtSiHCl_2} > \underset{1}{MeSiHCl_2} .$$

and for the hydrosilylation of vinylsilanes in the presence of H_2PtCl_6:[282]

$$\underset{6.75}{HSiCl_3} > \underset{2.88}{MeSiHCl_2} > \underset{1.62}{Me_2SiHCl} > \underset{1}{Et_3SiH} .$$

Analogous series were obtained for the hydrosilylation of octene in the presence of phosphinonickel complexes[234] and of allylmalonic acid esters in the presence of H_2PtCl_6.[283]

The reactivity of hydrosilacycloalkanes in the reaction with ethylene in the presence of 5% Pt/C decreases in the sequence[284]



Under these conditions, all the hydrosilacycloalkanes are much more reactive than their acyclic analogues[284]. In the competition reaction, the addition of the latter is inhibited until most of the hydrosilacycloalkane has reacted.

Furyl-[285], thienyl-[286], and ferrocenyl-hydrosilanes[287-290] are also very reactive.

In the reaction with α-methylstyrene in the presence of H_2PtCl_6, cyclic hydrosilanes can be arranged in the following sequence in terms of decreasing reactivity:

$$(MeSiHO)_4 > (EtSiHO)_4 > (MeSiHNH)_4 > (EtSiHNH)_4 > (EtSiHS)_3 .$$

The series is consistent with the sequence based on the decrease of the electronegativity of the heteroatom[291,292].

Hydrosilazanes $(Me_2SiH)_2NR$ are also less reactive than the corresponding hydrosiloxanes[33,293]. The rate of their addition to allyldiethylamine decreases in the following sequence as a function of the group linked to the nitrogen atom[33,294]:

$$Ph > \text{iso-}Bu > H > Me, PhCH_2 .$$

The trisilylamines $(Me_3Si)_2NSiHMe_2$ and $(Me_2SiH)_3N$ react with olefins with difficulty in the presence of H_2PtCl_6.[269,295,296] This cannot be accounted for solely by the influence of steric factors, because under these conditions tris(dimethylsilyl)methane adds to octene with a satisfactory yield[269]. The increase of electron density at the silicon atom owing to the $p_\pi-d_\pi$ interaction in the N–Si bond plays a definite role in the decrease of the reactivity of compounds with an N–Si–H group. The sequence based on the decrease of reactivity

$$(Me_2SiH)_2NH > (Me_2SiH)_3N > Me_2SiHNR_2$$

shows that the reactivities of these compounds in the hydrosilylation reactions are determined by a set of different factors (conjugation, capacity for complex formation with the catalyst, and steric hindrance).

In contrast to trichlorosilane, in the reaction with alk-2-enes and alk-3-enes dichlorosilane forms in the presence of H_2PtCl_6 the corresponding 2- and 3-substituted derivatives instead of the n-alkyl derivatives[297].

Kinetic studies on the hydrosilylation of hexene, styrene, and its derivatives by organosilanes $RSiH_3$ in the presence of H_2PtCl_6 have led to the conclusion that hydrosilanes with aromatic groups are more reactive than alkylsilanes[24] and attack on the reaction centre by the olefin proceeds more readily the more marked are the electron-accepting properties of the substituent at the silicon atom[24,25,298]:

$$ClC_6H_4 > C_6H_5 > \text{cyclo-}C_6H_{11} > C_4H_9 > \text{iso-}C_5H_{11} .$$

The steric effects at the first stage of the reaction do not play a significant role. As the number of substituents on the hydrosilane increases, its reactivity falls[28]:

$$RSiH_3 > R_2SiH_2 > R_3SiH .$$

The hydrosilylation of *N*-propargylpiperidine, *N*-propargylperhydroazepine, and *N*-propargylmorpholine with triethylsilane in the presence of H_2PtCl_6 results in the formation of γ-adducts (relative to nitrogen) having the *trans*-configuration. On passing from triethylsilane to dibutylmethylsilane, 3*H*-heptamethyldisiloxane, and triethoxysilane, there is a gradual increase of the content of the β-adduct in the reaction products and for the last compound the yields of the γ- and β-adducts are almost equal[299].

The mode of hydrosilylation of styrene by halogenohydrosilanes in the presence of H_2PtCl_6 and the yield of products depend also on the nature of the halogen. The addition of alkylfluorosilanes leads to a mixture of α- and β-isomers[300-302]. Under these conditions, the formation of the α-isomer predominates in the presence of dialkylfluorosilanes[300]. Hydrofluorophenyl-, hydrofluorodiphenyl-, and hydrofluoro-α-naphthyl-silanes are more reactive in competition addition reactions than the corresponding chlorohydrosilanes[303]. At the same time arylfluorohydrosilanes form a mixture of isomers with the α-isomer predominating, while the arylchlorosilyl group adds only to the terminal carbon atom of the double bond[303,304].

The ratio of α- and β-isomers formed in the hydrosilylation of acrylonitrile in the presence of the ternary catalyst $Bu_3N-(Me_2NCH_2)_2-CuCl$ decreases after the introduction of alkyl groups into the hydrosilane molecule[305]:

$$HSiCl_3 > PhSiHCl_2 > MeSiHCl_2 > Ph_2SiHCl > PhMeSiHCl > Me_2SiHCl .$$

The relative rate constants for the interaction of hexene with hydrosilanes under the influence of γ-radiation decrease in the following sequence[263]:

$$\begin{array}{ccccc} HSiCl_3 & > & Ph_3SiH & > & Et_3SiH \\ 100 & & 10 & & 1 \\ Ph_3SiH & > & Ph_2SiHCl & > & PhSiHCl_2 \\ 13.6 & & 2.4 & & 1 \end{array}$$

The first sequence can be accounted for by the activating influence of electronegative substituents on the reactivity of the intermediate radicals $X_3SiCh_3\dot{C}HR$, and the second by the possibility of the stabilisation of the chlorosilane radicals due to $p_\pi-d_\pi$ interaction.

2. The Influence of the Structure of the Unsaturated Compound on the Rate and Mode of Hydrosilylation

Certain regularities have also been established in the study of the influence of the structure of the unsaturated compound on the rate and mode of hydrosilylation. In the hydrosilylation of the C=C double bond in the presence of H_2PtCl_6, the reactivity of olefins is proportional to the electron density in the double bond[306]. Steric hindrance decreases the rate of reaction. The following reactivity series have been established for the addition of trichlorosilane to olefins at 120°C in the presence of H_2PtCl_6:[306]

$$\begin{array}{ccccccc} BuCH_2CH=CH_2 & > & Bu(CH_2)_4CH=CH_2 & > & cis\text{-}BuCH=CHMe & > & trans\text{-}BuCH=CHMe \\ 1.5 & & 1 & & 0.73 & & 0.5 \end{array}$$

$$> cis\text{-}(trans\text{-})\,PrCH=CHEt$$
$$0.35$$

$$\begin{array}{ccccccc} Me_3CCH_2CH=CH_2 & > & Me_3CCH=CH_2 & > & trans\text{-}Me_2CHCH=CHMe \\ 1.5 & & 1.06 & & 0.68 \end{array}$$

$$\begin{array}{ccccc} PhCH_2CH=CH_2 & > & PhCH=CH_2 \\ 0.71 & & 0.54 \end{array} .$$

Another series was obtained in the hydrosilylation by alkyldichlorosilanes in the presence of H_2PtCl_6:[281]

$$\begin{array}{ccccc} PrCH=CH_2 & > & BuCH=CH_2 & > & AmCH=CH_2 \\ 1.39 & & 1.16 & & 1 \end{array} .$$

In the presence of H_2PtCl_6 [297] and $[(C_2H_4)_2RhCl]_2$, [198] alk-2-enes and alk-3-enes react with greater difficulty than alk-1-enes. Thus, whereas the yield of trichloro-n-heptylsilane in the reaction of trichlorosilane with hept-1-ene in the presence of $[(C_2H_4)_2RhCl]_2$ is 54% (85°C, 2 h), its yield in the reaction with *cis*-hept-2-ene does not exceed 10%, while in the reaction with *trans*-hept-2-ene it is only 1%.[198] On the other hand, in the presence of $(Ph_3P)_4Pt$ [137] and peroxides [271], the alkenes could not be hydrosilylated at all.

The hydrosilylation of compounds whose molecules contain several double bonds permits the comparative estimation of their reactivities. Thus the addition of dichloromethylsilane to hexa-1,5-diene (equivalent double

bonds) in the presence of H_2PtCl_6 involves both bonds[70,307], while in the addition to the natural terpene myrcene

$$(CH_3)_2\overset{(c)}{C}=CHCH_2CH_2C(\overset{(b)}{CH_2})-\overset{(a)}{CH}=CH_2,$$

which has three types of double bonds, the reactivity of the latter in the reaction with trichlorosilane in the presence of H_2PtCl_6 decreases in the sequence (a) > (b) > (c).[308,309]

The study of the hydrosilylation of unsaturated silanes containing two different unsaturated groups at the silicon atom by chlorodimethylsilane in the presence of H_2PtCl_6 made it possible to establish the following reactivity series[282]:

$$HC\equiv C>CH_2=CH>CH_2=CHCH_2>CH_2=C(CH_3)CH_2>CH_2=CH>CH_2=CHC_6H_4 .$$

In the reaction with phenylsilane, the reactivity of unsaturated compounds decreases in the sequence[25,298,310]:

$$p\text{-}CH_3C_6H_4CH=CH_2>PhCH=CH_2>p\text{-}ClC_6H_4CH=CH_2.$$

A similar behaviour, involving an increase of the conversion and of the rate of reaction with increase of electron density in the double bond, was observed also in the hydrosilylation of substituted styrenes by dichloromethylsilane in the presence of the platinum–styrene complexes[98].

Certain other reactivity series of unsaturated compounds have also been obtained[291,311]; in reactions with hydrocyclosiloxanes:

$$PhCH=CH_2>PhCH(CH_3)=CH_2>CH_2=C(CH_3)COOMe>CH_2=CHCH_2CN;$$

in reactions with hydrocyclosilazanes:

$$PhCH=CH_2>CH_2=C(CH_3)COOMe>CH_2=CHCH_2CN>CH_2=CHCN;$$

in reactions with hydrocyclosilthianes:

$$PhCH(CH_3)=CH_2>CH_2=CHCH_2CN>CH_2=CHCN.$$

In the hydrosilylation of monosubstituted acetylenes $RC\equiv CH$ by triethylsilane in the presence of H_2PtCl_6, the amount of β-isomers increases with enhancement of the electron-donating properties of R.[21,312] The use of tetrahydrofuran as the reaction medium decreases the amount of the α-isomer[21,313,314].

IV. NEW APPLICATIONS OF HYDROSILYLATION

During recent years, it has been possible to achieve for the first time the hydrosilylation of the C=N, N=N, and N=O bonds.

Triethylsilane adds to *N*-substituted aldimines in the presence of $ZnCl_2$ at 150°C:[315]

$$PhCH=NR + HSiEt_3 \rightarrow PhCH_2N(R)SiEt_3 .$$

Nickel and platinum halides behave similarly[316]. Rhodium complexes are much more active catalysts of the hydrosilylation of ketimines by trialkylsilanes and diorganosilanes, which makes it possible to carry out the addition at a lower temperature (30–50°C).[220,222] Their reactivity decreases in the sequence[221]

$$(Ph_3P)_3RhCl \gg (Ph_3P)_2Rh(CO)Cl > [(\text{hexa-1,5-diene})RhCl]_2 > [(\text{cyclo-octa-1,5-diene})RhCl]_2 > PdCl_2 > (Ph_3P)_2PdCl_2 .$$

Palladium catalysts are less active but they can be used also for the addition of trialkylsilanes to the isocyanate group[317].

Trimethylsilane reacts with pyridine in the presence of palladium on charcoal (30°C, 25 h) with formation of *N*-trimethylsilyl-1,2-dihydropyridine (25%), *N*-trimethylsilyl-1,4-dihydropyridine (35%), *NN'*-bis(trimethylsilyl)-1,1'-dihydro-4,4'bipyridyl (25%), *N*-trimethylsilyl-1,2,3,6-tetrahydropyridine (12%), and many other trimethylsilylhydropyridines[318–321]. The Pd/C catalyst is more active than Rh/C, $PdCl_2$, Pt/C, and Ru/C. However, Rh/C acts more selectively, directing the process mainly towards the formation of *N*-trimethylsilyl-1,4-dihydropyridine[320,321]. In the reaction involving 3-methylpyridine in the presence of Pd/C, there is quantitative addition to the 1,4-positions. 4-Methylpyridine reacts four times as slowly as pyridine and the addition of trimethylsilane to 2-methylpyridine could not be achieved at all[321].

Triphenylsilane adds to the N=N bond of diethylazodicarboxylate in the presence of t-butyl peroxide in boiling benzene. The reaction proceeds slowly: the attainment of a 70% yield of the product requires eleven days. The addition was much faster under ultraviolet irradiation in the presence of t-butyl peroxide (3.5 h, yield 77%):[274,322]

$$EtOOCN=NCOOEt + HSiPh_3 \rightarrow EtOOCN(SiPh_3)-NHCOOEt .$$

At a higher temperature (140°C), triphenylsilane adds to azobenzene (yield 30%):[322]

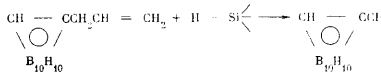
$$PhN=NPh + HSiPh_3 \rightarrow PhNHNPhSiPh_3 .$$

Trimethylsilane adds to the N=O bond in trifluoronitrosomethane both under the influence of ultraviolet light and in the presence of H_2PtCl_6:[323]

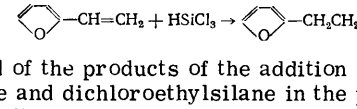
$$CF_3N=O + HSiMe_3 \rightarrow CF_3NHOSiMe_3 + (CF_3)_2NOSiMe_3 .$$

Together with the normal addition products (43 and 74% respectively), the *O*-trimethylsilyl derivative of bis(trifluoromethyl)hydroxylamine is also formed (28 and 16%).[323] Under the influence of ultraviolet light, trichlorosilane adds slowly to trifluoronitrosomethane (15 h, yield 17%). Trifluorosilane is much more reactive under these conditions (yield 80%).[324]

The addition of chlorohydrosilanes[325–330], alkoxyhydrosilanes[331–333], and hydrosiloxanes[326,334–338] to alkenylcarboranes in the presence of Pt/C, H_2PtCl_6, $FeCl_3$, or in the absence of catalysts (>200°C) leads to the corresponding alkylcarboranylsilanes and carboranylsiloxanes:



Trichlorosilane adds to 2-vinylfuran in the presence of H_2PtCl_6 on heating a tetrahydrofuran solution in a closed vessel to 80–85°C. After heating for 18 h, the yield of the hydrosilylation product is 60%:[339]



The yield of the products of the addition of dichloromethylsilane and dichloroethylsilane in the presence of H_2PtCl_6 is 70%, while the yield of the addition reactions involving ethoxy- and acetoxy-silanes is lower (approximately 50%) and that of the reactions with trialkylsilanes is lower still (approximately 30%).[339,340]

Unsaturated derivatives and other oxygen-containing heterocycles, namely oxetan[341–343] and tetrahydropyran[344–348], have been hydrosilylated.

It has been shown that alkenyl sulphides[349-353] combine with various hydrosilanes in the presence of platinum catalysts, like unsaturated ethers[1,3]:

$$RSCH_2CH{=}CH_2 + H{-}Si\lessgtr \rightarrow RSCH_2CH_2CH_2Si\lessgtr .$$

The hydrosilylation of unsaturated sulphones proceeds in the same way[354].

In the presence of several double bonds in the molecule whose positions relative to the sulphur atom are different, the bond most remote from the sulphur atom is the first to be hydrosilylated[355]:

$$CH_2{=}CH(CH_2)_nSCH{=}CH_2 + H{-}Si\lessgtr \rightarrow \gtrless SiCH_2CH_2(CH_2)_nSCH{=}CH_2 .$$

When the reaction was initiated by ultraviolet light, it was possible to achieve the quantitative addition of trichlorosilane, dichloromethylsilane, and trimethylsilane to bis(trifluoromethyl)aminoethylene[356,357]:

$$(CF_3)_2NCH{=}CH_2 + HSiCl_3 \rightarrow (CF_3)_2NCH_2CH_2SiCl_3 .$$

Azines derived from unsaturated ketones[358,359], 1-vinylsilatrane[369], and ketenes[361,362] have been hydrosilylated in the presence of H_2PtCl_6:

$$[CH_2{=}CHCH_2CH_2C(CH_3){=}N{-}]_2 + H{-}Si\lessgtr \rightarrow \left[\gtrless Si(CH_2)_4C(CH_3){=}N{-}\right]_2 ;$$

$$N(CH_2CH_2O)_3SiCH{=}CH_2 + H{-}Si\lessgtr \rightarrow N(CH_2CH_2O)_3SiCH_2CH_2Si\lessgtr ;$$

$$R_2C{=}C{=}O + H{-}Si\lessgtr \rightarrow R_2C{=}CHOSi\lessgtr .$$

It has been shown for the reaction with optically active hydrosilanes that the hydrosilylation of alkenes in the presence of H_2PtCl_6 and $[(C_2H_4).PtCl_2]_2$ proceeds with retention of configuration[90,363,364], which confirms to a certain extent the coordination reaction mechanism put forward[2,12,16,25,28,31,77,86,90,291,298,306,364-367].

V. ANOMALOUS AND SIDE REACTIONS

In many cases the hydrosilylation of alkenes is accompanied by other processes associated with the reactions of the initial olefin, hydrosilane, or reaction intermediates. The commonest reactions of this kind are isomerisation[86,143,185,188,197,198,254,256,296,368,369] and hydrogenation[25,254,310] of the initial alkene and in some cases telomerisation[187,270].

The reaction of trichlorosilanes with 1-propylcyclohexene in the presence of H_2PtCl_6 proceeds with migration of the double bond and involves the formation of trichloro-3-cyclohexylpropylsilane, while the unreacted olefin consists of 1-propylcyclohexene (33%), 3-propylcyclohexene (3%), 4-propylcyclohexene (3%), and 1-propenylcyclohexane (2%):[85]

$$\bigcirc{-}C_3H_7 + HSiCl_3 \rightarrow \bigcirc{-}(CH_2)_3SiCl_3 .$$

Isomerisation is observed also in the hydrosilylation of β-pinene[370,371], and bicyclo[2,2,1]hepta-2,5-diene[372].

The hydrosilylation of arylalkenes $Ph(CH_2)_nCH{=}CH_2$ (n = 1 or 2) and $PhCH{=}CH(CH_2)_mH$ (m = 0-4) in the presence of H_2PtCl_6 is accompanied by isomerisation and leads to the formation of two products: with a terminal silyl group and with a silyl group located at the carbon atom adjoining the phenyl group[303]. For example:

$$PhCH_2CH{=}CH_2 + HSiCl_3 \rightarrow Ph(CH_2)_3SiCl_3 + PhCH(SiCl_3)CH_2CH_3 ;$$
$$PhCH{=}CHCH_3 + Me_2SiHCl \rightarrow Ph(CH_2)_3SiClMe_2 + PhCH(SiClMe_2)CH_2CH_3 .$$

With increase of n, the amount of the isomer with a terminal silyl group increases, falling as m increases. The yield of this isomer rises in the following sequence of hydrosilanes[303]:

$$Me_2SiHCl > MeSiHCl_2 > HSiCl_3 .$$

The hydrosilylation of monosubstituted acetylenes in the presence of a mixture of nickel acetylacetonate and triethylaluminium is accompanied by dimerisation[239]:

$$2\,RC{\equiv}CH + HSiX_3 \rightarrow CH_2{=}CRCR{=}CHSiX_3 + RCH{=}CHCR{=}CHSiX_3 .$$

Dimerisation also occurs in the hydrosilylation of buta-1,3-diene in the presence of palladium catalysts[140,169,170]:

$$CH_2{=}CHCH{=}CH_2 + R_3SiH \rightarrow CH_3CH{=}CHCH_2CH_2CH{=}CHCH_2SiR_3 .$$

Various side reactions can occur in the hydrosilylation of unsaturated compounds containing functional groups capable of reacting with hydrosilanes. Thus, whereas trialkylsilanes add to perfluorocyclobutene on heating to 250°C, the reaction with 1,2-dichloro-3,3,4,4-tetrafluorocyclobutene under analogous conditions involves condensation and reduction instead of addition[373]:

$$\begin{matrix} CF_2{-}CCl \\ | \quad \| \\ CF_2{-}CCl \end{matrix} \xrightarrow{R_3SiH} \begin{matrix} CF_2{-}CCl \\ | \quad \| \\ CF_2{-}CSiR_3 \end{matrix} + \begin{matrix} CF_2{-}CH \\ | \quad \| \\ CF_2{-}CCl \end{matrix} + R_3SiCl + HCl .$$

The hydrosilylation of allyl chloride[374,375] and methylallyl chloride[376] in the presence of H_2PtCl_6 is also accompanied by reduction. The ratio of the addition and reduction products depends on the structure of the hydrosilane, decreasing as chlorine atoms are replaced by methyl, phenyl, and ethoxy-groups[374,375]:

$$\underset{5.7}{HSiCl_3} > \underset{2.7}{MeSiHCl_2} > \underset{1.82}{PhSiHCl_2} > \underset{1.45}{Me_2SiHCl} > \underset{1.2}{MePhSiHCl} > \underset{0.38}{Ph_2SiHCl} > \underset{0.11}{MePh_2SiH}$$
$$EtSiH_2Cl > EtSiHCl_2 > Et_2SiHCl > (EtO)_3SiH > Et_3SiH$$

In the presence of H_2PtCl_6, triphenylsilane and methyldiphenylsilane reduce the nitro-group of *m*-nitrostyrene, while alkylchlorohydrosilanes add to the C=C double bond without affecting the nitro-group[377].

In the hydrosilylation of unsaturated esters by chlorohydrosilanes and alkoxyhydrosilanes, the cleavage of the C-O bond is also frequently observed[378-382]. For example, the hydrosilylation of allyl trifluoroacetate by dichloromethylsilane in the presence of H_2PtCl_6 involves the formation, together with dichloro-[3-(trifluoroacetoxy)-propyl]methylsilane (52%), of a number of other cleavage, reduction, and further reaction products[384]:

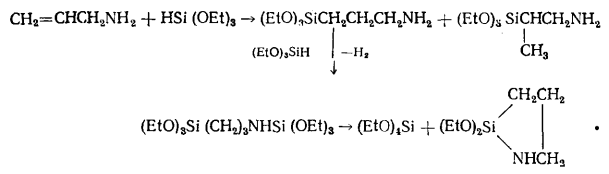
$$CF_3COOCH_2CH{=}CH_2 + MeSiHCl_2 \rightarrow \begin{cases} CF_3COO(CH_2)_3SiCl_2Me & (52.2\%) \\ CF_3COOCH_2CH_2CH_3 & (3.3\%) \\ CH_3SiHCl(OCOCF_3) & (\sim 13\%) \\ + MeSiCl_3 & (9.4\%) \\ + PrSiCl_2Me & (12.2\%) \\ + CF_3COO(CH_2)_3Si(OCOCF_3)ClMe & (7.3\%) \end{cases} .$$

The addition of trichlorosilane to vinyl acetate under the influence of γ-radiation is accompanied by the reduction of the carbonyl group to the methylene group[265]:

$$CH_3COOCH{=}CH_2 + HSiCl_3 \rightarrow CH_3CH_2OCH_2CH_2SiCl_3 .$$

Belyakova et al.[385] was the first to show convincingly that the hydrosilylation of unsaturated compounds containing other functional groups[1,3] in the presence of H_2PtCl_6

may involve the silylation not only of the hydroxy- or carboxy-group, but also of the primary amino-group:



In hydrosilylation in the presence of platinum catalysts, the disproportionation of the initial hydrosilane is sometimes observed[296, 369, 375, 384, 386–390], for example:

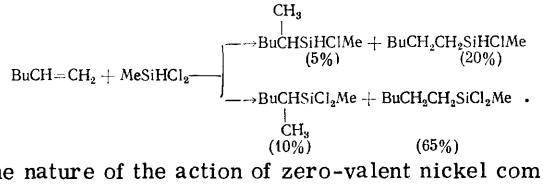
$$2\,PhSiHCl_2 \rightarrow Ph_2SiHCl + HSiCl_3\ ;$$

$$2\,Et_2SiHF \rightarrow Et_2SiH_2 + Et_2SiF_2\ .$$

In the presence of nickel catalysts this takes place to a more marked extent. The disproportionation of the hydrosilane in the hydrosilylation of alkenes, styrene, cyclohexene, and cyclo-octadiene in the presence of phosphinonickel complexes involves the formation of two different adducts[233, 234]:

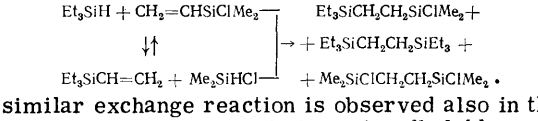
$$RCH{=}CH_2 + MeSiHCl_2 \rightarrow RCH_2CH_2SiCl_2Me + RCH_2CH_2SiHClMe + MeSiCl_3\ .$$

When the reaction of dichloromethylsilane with hex-1-ene is carried out in the presence of $[Me_3SiCH_2PBu_2]_2NiBr_2$ (120°C, 6 h), as many as four adducts are formed[232]:



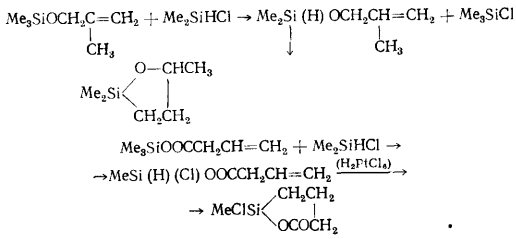
The nature of the action of zero-valent nickel complexes, for example $(Ph_2PCH_2)_2(C_2H_4)Ni$, is comparable to that of the action of the corresponding nickel(II) complexes, but in the presence of the latter the induction period is longer[233]. The yield of the reaction product and the ratio of the anomalous and normal adducts increase with increase of the electron-donating capacity of the ligands and substituents in the olefin[234].

The reaction of triorganosilanes with chlorovinylsilanes is accompanied by the exchange of the hydrogen atom and the vinyl group of the initial silanes[391]:

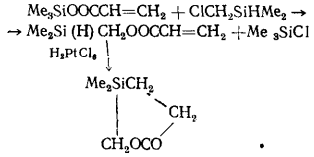


A similar exchange reaction is observed also in the hydrosilylation of alkoxyvinylsilanes by alkylchlorohydrosilanes[392] and of pentamethylvinyldisilane by dichloromethylsilane[393].

The hydrosilylation of trimethylsilyl ethers of unsaturated alcohols[389, 394–396] and esters of unsaturated acids[397–399] by chlorodimethylsilane in the presence of H_2PtCl_6 is accompanied by the transilylation of the initial unsaturated silane with subsequent cyclisation owing to the intramolecular hydrosilylation of the intermediate allyloxy- and acyloxy-hydrosilanes, for example:



The interaction of acryloyloxytrimethylsilane with (chloromethyl)dimethylsilane proceeds with dissociation of the C–Cl bond and the formation of a six-membered lactone[400]:



During the recent 1½ years (from January 1975 to July 1976), 200 new studies on the hydrosilylation reaction were published, which indicates the growing popularity of this method of synthesis of organosilicon monomers and polymers.

A detailed study was made of the catalytic activity of nickel catalysts in reactions with carbonyl compounds[401–404] and of rhodium catalysts in reactions with olefins[405]. It has been shown[406] that $(Ph_3P)_3RhCl$ is an effective catalyst of the hydrosilylation of acrylonitrile not only by chlorohydrosilanes but also by trialkylsilanes (the α-isomers are formed). The hydrosilylation of buta-1,3-diene has been investigated in detail in the presence of rhodium[407], palladium[408, 409], and nickel[410, 411] catalysts. New catalytic systems have been proposed for this reaction: nickel[412] or cobalt[413] salts mixed with sodium hydrodi-(2-methoxyethoxy)aluminate.

The study of hydrosilylation established that the reactivities of hydrosiloxanes[414] and vinylsiloxanes[415] $Me_{3-n}RSi(OSiMe_3)_n$ (R = H or vinyl) in this reaction decrease with increase of n. In the hydrosilylation of acetylenic compounds[416–420], the reaction rate increases with electron density in the triple bond and is to a large extent determined by the steric properties of the groups attached to the silicon atom.

It has been found that the hydrosilylation of divinyl sulphide by diethylsilane is accompanied by cyclisation with formation of a derivative of a new heterocyclic system—3,3-diethyl-2,4-dimethyl-1-thia-3-silacyclobutane[421].

Studies on the asymmetric hydrosilylation[422–428] of the C=C, C=N, and C=O bonds are developing to an increasing extent, which is of interest both for the synthesis of chiral amines and alcohols with a high optical purity and for the determination of the mechanism of the hydrosilylation reaction.

REFERENCES

1. E. Lukevics and M. G. Voronkov, "Gidrosililirovanie, Gidrogermilirovanie i Godrostannilirovanie" (Hydrosilylation, Hydrogermylation, and Hydrostannylation), Izd. Akad. Nauk Latv. SSR, Riga, 1964.
2. C. Eaborn and R. W. Bott, in "Organometallic Compounds of the Group IV Elements", New York, 1968, Vol. 1, p. 105.
3. M. G. Pomerantseva, Z. V. Belyakova, S. A. Golubtsov, and N. S. Shvarts, "Poluchenie Karbofunktsional'nykh Organosilanov po Reaktsii Prisoedineniya" (The Synthesis of Carbonfunctional Organosilanes by the Addition Reactions), Izd. NIITEKhIM, Moscow, 1971.
4. F. W. Stacey and J. F. Harris, in "Organic Reactions", New York–London, 1963, Vol. 13, p. 91.
5. V. Bazant, V. Chvalovsky, and J. Rathousky, "Organosilicon Compounds", Prague, 1965, Vol. 1, p. 139.
6. R. A. Benkeser, Pure Appl. Chem., **13**, 133 (1966).

7. R. Calas, Pure Appl. Chem., **13**, 61 (1966).
8. R. N. Meals, Pure Appl. Chem., **13**, 141 (1966).
9. R. A. Benkeser, Pure Appl. Chem., **19**, 389 (1969).
10. D. Elad, "Organic Photochemistry", New York, 1969, Vol. 2, p. 168.
11. J. Tsuji, in "Advances in Organic Chemistry", New York, 1969, Vol. 6, p. 206.
12. A. J. Chalk, Trans. N. Y. Acad. Sci., Ser. II, **32**, 481 (1970).
13. N. V. Komarov and V. K. Roman, Uspekhi Khim., 39, 1220 (1970) [Russ. Chem. Rev., No. 7 (1970)].
14. R. A. Benkeser, Accounts Chem. Research, **4**, 94 (1971).
15. R. W. Bott, Organomet. Chem. Rev., **7B**, 1 (1971).
16. A. J. Chalk, Ann. N. Y. Acad. Sci., **172B**, 533 (1971).
17. C. A. Tolman, in "Transition Metal Hydrides", New York, 1971, p. 293.
18. M. Kraus, Chem. Listy, **66**, 1281 (1972).
19. E. Lukevics and A. E. Pestunovich, Uspekhi Khim., **41**, 1994 (1972) [Russ. Chem. Rev., No. 11 (1972)].
20. V. P. Kozyukov, V. D. Sheludyakov, and V. F. Mironov, Uspekhi Khim., **42**, 1451 (1973) [Russ. Chem. Rev., No. 8 (1973)].
21. S. P. Sushchinskaya, Candidate's Thesis, Irkutsk Institute of General Chemistry, Siberian Division of the USSR Academy of Sciences, Irkutsk, 1973.
22. K. A. Andrianov, B. G. Savin, A. M. Evdokimov, and O. V. Budanova, Zhur. Obshch. Khim., **44**, 2140 (1974).
23. L. A. Grigor'eva and V. O. Reikhsfel'd, Vysokomol. Soed., **6**, 988 (1964).
24. G. N. Koroleva and V. O. Reikhsfel'd, Zhur. Obshch. Khim., **37**, 2559 (1967).
25. G. N. Koroleva and V. O. Reikhsfel'd, Zhur. Obshch. Khim., **37**, 2768 (1967).
26. E. P. Lebedev and V. O. Reikhsfel'd, Zhur. Obshch. Khim., **38**, 655 (1968).
27. V. O. Reikhsfel'd and L. A. Grigor'eva, Vysokomol. Soed., **6**, 969 (1964).
28. V. O. Reikhsfel'd and G. N. Koroleva, Zhur. Obshch. Khim., **36**, 1474 (1966).
29. V. O. Reikhsfel'd and G. N. Koroleva, Zhur. Obshch. Khim., **37**, 2774 (1967).
30. Dutch Appl. 6 511 871 (1966); Chem. Abs., **65**, 3907 (1966).
31. M. Čapka, P. Svoboda, V. Bažant, and V. Chvalovsky, Coll. Czech. Chem. Comm., **36**, 2785 (1971).
32. V. B. Puchnarevič, J. Včelak, M. G. Voronkov, and V. Chvalovsky, Coll. Czech. Chem. Comm., **39**, 2616 (1974).
33. V. M. Kopylov, Candidate's Thesis, Lomonosov Moscow Institute of Fine Chemical Engineering, Moscow, 1969.
34. I. M. Gverdtsiteli, L. V. Baramidze, M. I. Dzheliya, and M. D. Nadirashvili, Soobshch. Akad. Nauk Gruz. SSR, **73**, 609 (1974).
35. BRD Appl. 2 030 653 (1971); Chem. Abs., **74**, 77 232 (1971).
36. B. Appl. 940 190 (1963); Chem. Abs., **60**, 14 688 (1964).
37. BRD P. 1 165 027 (1964); Chem. Abs., **60**, 14 540 (1964).
38. B. P. 1 221 156 (1971); Chem. Abs., **74**, 115 909 (1971).
39. BRD Appl. 1 938 743 (1971); Chem. Abs., **75**, 20 588 (1971).
40. Japanese P. 7346 (1974); Chem. Abs., **81**, 27 362 (1974).
41. DDR P. 55 139 (1957).
42. B. P. 1 090 958 (1967); Chem. Abs., **68**, 22 621 (1968).
43. B. P. 1 144 594 (1969); Chem. Abs., **71**, 4341 (1969).
44. US P. 3 057 901 (1962); Chem. Abs., **58**, 9339 (1963).
45. US P. 3 120 546 (1964); Chem. Abs., **60**, 10 715 (1964).
46. US P. 3 347 897 (1967); Chem. Abs., **68**, 4973 (1968).
47. French P. 1 387 339 (1965); Chem. Abs., **63**, 7043 (1965).
48. US P. 3 162 663 (1964); Chem. Abs., **63**, 1904 (1965).
49. French P. 1 549 776 (1968); Chem. Abs., **72**, 21 780 (1970).
50. US P. 3 700 711 (1972); Chem. Abs., **78**, 43 688 (1973).
51. US P. 3 746 734 (1973); Chem. Abs., **79**, 127 002 (1973).
52. US P. 3 773 817 (1973); Chem. Abs., **80**, 37 272 (1974).
53. US P. 3 778 459 (1973); Chem. Abs., **80**, 70 952 (1974).
54. US P. 3 780 080 (1973); Chem. Abs., **80**, 70 953 (1974).
55. US P. 3 600 414 (1971); Chem. Abs., **75**, 153 074 (1971).
56. US P. 3 544 498 (1970); Chem. Abs., **74**, 43 654 (1971).
57. BRD Appl. 1 935 167 (1970); Chem. Abs., **72**, 79 940 (1970).
58. Japanese P. 92 453 (1973); Chem. Abs., **80**, 109 608 (1974).
59. French P. 1 361 690 (1964); Chem. Abs., **61**, 12 153 (1964).
60. US P. 3 220 972 (1965); Chem. Abs., **64**, 8 237 (1966).
61. B. P. 968 470 (1964); Chem. Abs., **61**, 12 035 (1964).
62. BRD Appl. 2 131 741 (1972); Chem. Abs., **78**, 72 355 (1973).
63. BRD Appl. 2 253 939 (1973); Chem. Abs., **79**, 106 095 (1973).
64. G. Greber and M. L. Hallensleben, "International Symposium on Organosilicon Chemistry, Scientific Communications, Prague, 1965", p. 91.
65. US P. 3 761 444 (1973); Chem. Abs., **80**, 15 686 (1974).
66. French P. 1 387 388 (1965); Chem. Abs., **64**, 2127 (1966).
67. Dutch Appl. 6 411 490 (1965); Chem. Abs., **63**, 13 317, (1965).
68. DDR P. 32 938 (1964); Chem. Abs., **63**, 9987 (1965).
69. BRD P. 1 210 846 (1966); Chem. Abs., **64**, 19 679 (1966).
70. B. P. 1 042 677 (1966); Chem. Abs., **65**, 18 407 (1966).
71. B. P. 949 126 (1969); Chem. Abs., **76**, 25 942 (1972).
72. US P. 3 258 477 (1966); Chem. Abs., **65**, 12 237 (1966).
73. French P. 1 385 096 (1965); Chem. Abs., **62**, 10 554 (1965).
74. French P. 1 352 325 (1964); Chem. Abs., **62**, 2890 (1965).
75. French P. 1 437 281 (1966); Chem. Abs., **66**, 28 884 (1967).
76. US P. 3 355 425 (1967); Chem. Abs., **68**, 22 395 (1968).
77. US P. 3 427 271 (1969); Chem. Abs., **70**, 78 566 (1969).

78. BRD Appl. 1 936 068 (1970); Chem. Abs., 72, 100 873 (1970).
79. US P. 3 576 027 (1971).
80. US P. 3 398 174 (1968).
81. B. P. 1 107 192 (1968); Brit. Pat. Abstr., 8, 10 (1968).
82. French P. 1 361 705 (1964); Chem. Abs., 61, 13 451 (1964).
83. BRD P. 1 495 917 (1969); Auszüge Off., 2, 898 (1969).
84. R. A. Benkeser and R. F. Cunico, J. Organomet. Chem., 6, 441 (1966).
85. R. A. Benkeser, S. Dunny, G. S. Li, P. G. Nerlekar, and S. D. Work, J. Amer. Chem. Soc., 90, 1871 (1968).
86. A. J. Chalk and J. E. Harrod, J. Amer. Chem. Soc., 87, 16 (1965).
87. B. P. 1 091 458 (1967); Chem. Abs., 68, 22 494 (1968).
88. French P. 1 582 748 (1969); Chem. Abs., 73, 46 424 (1970).
89. BRD P. 1 287 240 (1965); Auszüge Pat., 11, 455 (1965).
90. L. H. Sommer, K. W. Michael, and H. Fujimoto, J. Amer. Chem. Soc., 89, 1519 (1967).
91. K. Yamamoto and M. Kumada, J. Organomet. Chem., 13, 131 (1968).
92. B. P. 1 056 066 (1967); Chem. Abs., 67, 74 151 (1967).
93. French P. 1 558 735 (1969); Chem. Abs., 72, 43 851 (1970).
94. French P. 1 568 720 (1969); Chem. Abs., 72, 23 046 (1970).
95. Dutch Appl. 6 614 767 (1967); Chem. Abs., 67, 65 060 (1967).
96. B. P. 1 160 644 (1969); Chem. Abs., 71, 102 003 (1969).
97. B. P. 1 130 824 (1968); Chem. Abs., 70, 12 155 (1969).
98. M. I. Astrakhanov, Candidate's Thesis, Lensovet Leningrad Technological Institute, Leningrad, 1972.
99. M. I. Astrakhanov and V. O. Reikhsfel'd, Zhur. Obshch. Khim., 43, 2439 (1973).
100. V. O. Reikhsfel'd and M. I. Astrakhanov, in "Kremniiorganicheskie Materialy" (Organosilicon Materials), Leningrad, 1971, p. 50.
101. V. O. Reikhsfel'd and M. I. Astrakhanov, "V Mezhdunarodnaya Konferentsiya po Metalloorganicheskoi Khimii" (The Vth International Conference on Organometallic Chemistry), Moscow, 1971, Vol. 2, p. 196.
102. V. O. Reikhsfel'd and M. I. Astrakhanov, Zhur. Obshch. Khim., 43, 2431 (1973).
103. V. O. Reikhsfel'd, M. I. Astrakhanov, and E. G. Kagan, Zhur. Obshch. Khim., 40, 699 (1970).
104. Dutch Appl. 6 606 711 (1966); Chem. Abs., 66, 115 791 (1967).
105. US P. 3 607 832 (1971); Chem. Abs., 76, 15 577 (1972).
106. BRD Appl. 2 232 886 (1973); Chem. Abs., 78, 98 506 (1973).
107. French P. 1 548 775 (1968); Chem. Abs., 71, 91 641 (1969).
108. BRD Appl. 1 941 411 (1970); Chem. Abs., 74, 100 519 (1971).
109. BRD Appl. 2 307 085 (1973); Chem. Abs., 80, 16 134 (1974).
110. B. P. 1 060 420 (1967).
111. French Appl. 2 171 335 (1973); Chem. Abs., 80, 146 832 (1974).
112. French P. 1 480 409 (1967); Bull. Off., 8, 6472 (1967).
113. BRD P. 1 262 271 (1968); Auszüge Pat., 14, 831 (1968).
114. US P. 3 419 593 (1968); Offic. Gaz., 857, 1557 (1968).
115. BRD Appl. 2 062 816 (1972); Chem. Abs., 77, 115 957 (1972).
116. I. N. Lyashenko, N. S. Nametkin, and T. I. Chernysheva, Izv. Akad. Nauk SSSR, Ser. Khim., 1132 (1969).
117. US P. 3 426 057 (1969); Offic. Gaz., 859, 268 (1969).
118. BRD P. 1 165 028 (1964); Chem. Abs., 60, 14 540 (1964).
119. BRD P. 1 203 776 (1965); Chem. Abs., 64, 2126 (1965).
120. K. Yamamoto, T. Hayashi, and M. Kumada, J. Amer. Chem. Soc., 93, 5301 (1971).
121. K. Yamamoto, T. Hayashi, and M. Kumada, J. Organomet. Chem., 28, C37 (1971).
122. S. P. Sushchinskaya, V. B. Pukhnarevich, B. A. Trofimov, and M. G. Voronkov, "IV Vsesoyuznaya Konferentsiya po Khimii Atsetilena, Alma-Ata" (The IVth All-Union Conference on the Chemistry of Acetylene, Alma-Ata), 1972, Vol. 2, p. 109.
123. M. G. Voronkov, V. B. Pukhnarevich, S. P. Sushchinskaya, L. I. Kopylova, and B. A. Trofimov, Zhur. Obshch. Khim., 42, 2687 (1972).
124. French P. 1 361 706 (1964); Chem. Abs., 61, 14 862 (1964).
125. BRD P. 1 495 921 (1969); Auszüge Off., 2, 898 (1969).
126. US P. 3 159 601 (1964); Offic. Gaz., 809, 242 (1964).
127. US P. 3 159 662 (1964).
128. B. P. 980 665 (1965); Brit. Pat. Abstr., 5, 1 (1965).
129. BRD Appl. 2 161 716 (1973); Chem. Abs., 79, 66 562 (1973).
130. US P. 3 723 497 (1973); Chem. Abs., 79, 6549 (1973).
131. BRD P. 1 271 712 (1968); Chem. Abs., 70, 57 988 (1969).
132. M. Čapka, P. Svoboda, and J. Hetflejš, Coll. Czech. Chem. Comm., 38, 3830 (1973).
133. French P. 1 496 984 (1967); Bull. Offic., 8, 13 189 (1967).
134. US P. 3 410 886 (1968); Chem. Abs., 70, 47 584 (1969).
135. US P. 3 188 300 (1965); Chem. Abs., 63, 7043 (1965).
136. B. P. 1 104 206 (1968); Chem. Abs., 68, 105 349 (1968).
137. W. Fink, Helv. Chem. Acta, 54, 1304 (1971).
138. BRD Appl. 2 238 914 (1973); Chem. Abs., 78, 148 632 (1973).
139. French P. 1 524 288 (1963); Chem. Abs., 71, 22 766 (1969).
140. S. Takahashi, T. Shibano, and N. Hagihara, Chem. Comm., 161 (1969).
141. BRD Appl. 2 034 909 (1971); Chem. Abs., 74, 91 744 (1971).
142. K. Yamamoto, T. Hayashi, and M. Kumada, J. Organomet. Chem., 46, C65 (1972).
143. M. Čapka, P. Svoboda, M. Kraus, and J. Hetflejš, Chem. Ind. (London), 650 (1972).
144. M. Čapka and J. Hetflejš, Coll. Czech. Chem. Comm., 39, 154 (1974).

145. BRD Appl. 2 305 988 (1973); Chem. Abs., 80, 16 601 (1974).
146. French P. 1 437 798 (1966); Chem. Abs., 66, 19 033 (1967).
147. B. P. 1 058 022 (1967); Brit. Patent Abstr., 7, 5 (1967).
148. BRD Appl. 2 317 985 (1973); Chem. Abs., 80, 84 243 (1974).
149. US P. 2 453 234 (1969); Chem. Abs., 71, 71 368 (1969).
150. BRD P. 1 210 844 (1966); Chem. Abs., 64, 15 922 (1966).
151. M. F. Shostakovskii, A. S. Atavin, E. P. Vyalykh, G. M. Gavrilova, G. A. Kalabin, and B. A. Trofimov, Zhur. Obshch. Khim., 41, 613 (1971).
152. French P. 1 509 761 (1968); Chem. Abs., 70, 29 048 (1969).
153. BRD P. 1 161 270 (1964); Chem. Abs., 60, 10 717 (1964).
154. BRD P. 1 156 073 (1963); Chem. Abs., 60, 3008 (1964).
155. G. Rossmy and G. Koerner, Makromol. Chem., 73, 85 (1964).
156. K. A. Andrianov, B. G. Zavin, and A. M. Evdokimov, "IV Vsesoyuznaya Konferentsiya po Khimii Atsetilena, Alma-Ata" (The IVth All-Union Conference on the Chemistry of Acetylene, Alma-Ata), 1972, Vol. 3, p. 195.
157. US P. 3 488 319 (1970); Chem. Abs., 72, 79 828 (1970).
158. US P. 3 313 773 (1967); Chem. Abs., 67, 3316 (1967).
159. French Appl. 2 012 012 (1970); Chem. Abs., 73, 120 747 (1970).
160. BRD P. 125 988 (1968); Chem. Abs., 68, 95 946 (1968).
161. M. Kraus, Coll. Czech. Chem. Comm., 39, 1318 (1974).
162. M. Mejstřikova, R. Reřicka, and M. Kraus, Coll. Czech. Chem. Comm., 39, 135 (1974).
163. V. O. Reikhsfel'd, V. N. Vinogradov, N. A. Filippov, and G. P. Yavshits, USSR P. No. 383 715 (1973); Byul. Izobret., No. 24, 62 (1973).
164. V. O. Reikhsfel'd, V. N. Vinogradov, and N. A. Filippov, Zhur. Obshch. Khim., 43, 2216 (1973).
165. V. Vaisarová, J. Hetflejš, H. W. Krause, and H. Pracejus, Z. Chem., 14, 105 (1974).
166. BRD Appl. 2 033 661 (1971); Chem. Abs., 74, 125 833 (1971).
167. US P. 3 595 733 (1971).
168. M. Hara, K. Ohno, and J. Tsuji, Chem. Comm., 247 (1971).
169. S. Takahashi and N. Hagihara, J. Chem. Soc. Japan. Ind. Chem. Sect., 72, 1637 (1969).
170. S. Takahashi, T. Shibano, H. Kojima, and N. Hagihara, Organometal. Chem. Synth., 1, 193 (1971).
171. J. Tsuji, M. Hara, and K. Ohno, Chem. Comm., 247 (1971).
172. BRD P. 1 942 798 (1970); Chem. Abs., 73, 15 497 (1970).
173. Japanese P. 10 846 (1971); Chem. Abs., 75, 49 311 (1971).
174. Japanese P. 11 645 (1971); Chem. Abs., 75, 20 599 (1971).
175. Japanese P. 11 646 (1971); Chem. Abs., 75, 20 598 (1971).
176. J. Tsuji, M. Hara, and K. Ohno, Tetrahedron, 30, 2143 (1974).
177. BRD Appl. 2 260 260 (1973); Chem. Abs., 79, 78 953 (1973).
178. Y. Kiso, K. Yamamoto, K. Tamao, and M. Kumada, J. Amer. Chem. Soc., 94, 4373 (1972).
179. V. Vaisarová, M. Čapka, and J. Hetflejš, Synth. Inorg. Metal-Org. Chem., 2, 289 (1972).
180. V. Vaisarová, J. Langová, J. Hetflejš, G. Oehme, and H. Pracejus, Z. Chem., 14, 64 (1974).
181. Japanese P. 7416 (1973); Chem. Abs., 79, 53 532 (1973).
182. BRD Appl. 2 330 308 (1974); Chem. Abs., 80, 121 733 (1974).
183. E. H. Brooks, R. J. Crose, and F. Glocking, Inorg. Chim. Acta, 2, 17 (1968).
184. M. Čapka, P. Svoboda, J. Hetflejš, and V. Chvalovsky, "The Vth International Conference on Organometallic Chemistry, Moscow", 1971, Vol. 2, p. 533.
185. A. J. Chalk, J. Organomet. Chem., 21, 207 (1970).
186. B. P. 1 040 237 (1960); Chem. Abs., 65, 20 164 (1966).
187. F. DeCharentenay, J. A. Osborn, and G. Wilkinson, J. Chem. Soc. (A), 787 (1968).
188. R. N. Haszeldine, R. V. Parish, and D. J. Parry, J. Chem. Soc. (A), 683 (1969).
189. R. N. Haszeldine, R. V. Parish, and D. J. Parry, J. Organomet. Chem., 9, P13 (1967).
190. French P. 1 495 063 (1967); Bull. Offic., 8, 12 397 (1967).
191. Dutch Appl. 6 612 227 (1967); Chem. Abs., 67, 64 522 (1967).
192. I. Ojima, M. Kumagai, and Y. Nagai, J. Organomet. Chem., 66, C14 (1974).
193. P. Svoboda, M. Čapka, J. Hetflejš, and V. Chvalovsky, Coll. Czech. Chem. Comm., 37, 1585 (1972).
194. H. Sugiyama, S. Tsuchiya, S. Seto, Y. Senda, and S. Imaizumi, Tetrahedron Letters, 3291 (1974).
195. I. Ojima, T. Kogure, M. Nihonyanagi, and Y. Nagai, Bull. Chem. Soc. Japan, 45, 3232 (1972).
196. BRD Appl. 2 008 427 (1970); Chem. Abs., 73, 110 629 (1970).
197. P. Svoboda, M. Čapka, and J. Hetflejš, Coll. Czech. Chem. Comm., 38, 1235 (1973).
198. P. Svoboda, M. Čapka, and J. Hetflejš, Coll. Czech. Chem. Comm., 37, 3059 (1972).
199. M. L. Khidekel', P. S. Chekrii, and S. A. Shchepinov, "IVth Konferentsiya po Khimii i Primeneniyu Kremniiorganicheskikh Soedinenii, Tbilisi", (The IVth Conference on the Chemistry and Applications of Organosilicon Compounds, Tbilisi), 1968, p. 62.
200. M. L. Khidekel', S. A. Shchepinov, and P. S. Chekrii, "II Symp. intern. sur la chimie des composés organiques du silicium, Bordeaux, 1968" p. 105.
201. V. B. Panov, M. L. Khidekel', and S. A. Shchepinov, Izv. Akad. Nauk SSSR, Ser. Khim., 2397 (1968).
202. S. A. Shchepinov and M. L. Khidekel', USSR P. 234 364 (1967); Byul. Izobret., No. 4, 29 (1969).
203. S. A. Shchepinov, M. L. Khidekel', and G. V. Lagodzinskaya, Izv. Akad. Nauk SSSR, Ser. Khim., 2165 (1968).
204. French P. 1 366 279 (1964); Chem. Abs., 62, 2795 (1965).
205. US P. 3 296 291 (1967); Offic. Gaz., 834, 319 (1967).
206. B. P. 1 041 237 (1966); Chem. Abs., 65, 20 164 (1966).
207. R. J. P. Corriu and J. J. E. Moreau, Chem. Comm., 38 (1973).

208. R. J. P. Corriu and J. J. E. Moreau, J. Organomet. Chem., 64, C51 (1974).
209. T. Hayashi, K. Yamamoto, and M. Kumada, Tetrahedron Letters, 331 (1974).
210. I. Ojima, T. Kogure, M. Kumagai, S. Horiuchi, and T. Sato, J. Organomet. Chem., 122, 83 (1976).
211. I. Ojima, T. Kogure, and Y. Nagai, Tetrahedron Letters, 5035 (1972).
212. I. Ojima, T. Kogure, and Y. Nagai, Tetrahedron Letters, 1889 (1974).
213. I. Ojima, T. Kogure, and Y. Nagai, Chem. Letters, 541 (1973).
214. I. Ojima, T. Kogure, and M. Nihonyanagi, Bull. Chem. Soc. Japan, 45, 3232 (1972).
215. I. Ojima and Y. Nagai, Chem. Letters, 223 (1974).
216. I. Ojima, M. Nihonyanagi, and Y. Nagai, Chem. Comm., 938 (1972).
217. I. Ojima, M. Nihonyanagi, and Y. Nagai, Bull. Chem. Soc. Japan, 45, 3722 (1972).
218. K. Yamamoto, T. Hayashi, and M. Kumada, J. Organomet. Chem., 54, C45 (1973).
219. T. Hayashi, K. Yamamoto, and M. Kumada, Tetrahedron Letters, 3 (1975).
220. N. Langlois, T. P. Dang, and H. B. Kagan, Tetrahedron Letters, 4865 (1973).
221. I. Ojima, T. Kogure, and Y. Nagai, Tetrahedron Letters, 2475 (1973).
222. I. Ojima, S. Inaba, and Y. Nagai, J. Organomet. Chem., 72, C11 (1974).
223. T. Hayashi, K. Yamamoto, and M. Kumada, Tetrahedron Letters, 4405 (1974).
224. BRD Appl. 2 245 187 (1973); Chem. Abs., 79, 67 025 (1973).
225. M. Čapka, P. Svoboda, M. Cerny, and J. Hetflejš, Tetrahedron Letters, 4787 (1971).
226. I. Dietzmann, D. Tomanová, and J. Hetflejš, Coll. Czech. Chem. Comm., 39, 123 (1974).
227. P. Svoboda, M. Čapka, V. Chvalovsky, V. Bažant, J. Hetflejš, H. Jahr, and H. Pracejus, Z. Chem., 12, 153 (1972).
228. DDR P. 103 903 (1974); Chem. Abs., 81, 49 815 (1974).
229. French P. 1 520 444 (1968); Chem. Abs., 70, 107 091 (1969).
230. C. Eaborn, K. Odell, and A. Pidcock, J. Organomet. Chem., 63, 93 (1973).
231. E. W. Bennet and P. J. Orenski, J. Organomet. Chem., 28, 137 (1971).
232. BRD Appl. 2 302 231 (1973); Chem. Abs., 79, 105 400 (1973).
233. Y. Kiso, M. Kumada, K. Maeda, K. Sumitani, and K. Tamao, J. Organomet. Chem., 50, 311 (1973).
234. Y. Kiso, M. Kumada, K. Tamao, and M. Umeno, J. Organomet. Chem., 50, 297 (1973).
235. Y. Kiso, K. Tamao, and M. Kumada, Chem. Comm., 105 (1972).
236. M. Kumada, Y. Kiso, and M. Umeno, Chem. Comm., 611 (1970).
237. M. Kumada, K. Sumitani, Y. Kiso, K. Tamao, J. Organomet. Chem., 50, 319 (1973).
238. K. Yamamoto, Y. Uramoto, and M. Kumada, J. Organomet. Chem., 31, C9 (1971).
239. M. F. Lappert, T. A. Nile, and S. Takahashi, J. Organomet. Chem., 72, 425 (1974).
240. P. Svoboda, P. Sedlmayer, and J. Hetflejš, Coll. Czech. Chem. Comm., 38, 1783 (1973).
241. BRD Appl. 2 355 181 (1974); Chem. Abs., 81, 78 028 (1974).
242. Y. Kiso, K. Tamao, and M. Kumada, J. Organomet. Chem., 76, 95 (1974).
243. H. Okinoshima, K. Yamamoto, and M. Kumada, J. Amer. Chem. Soc., 94, 9263 (1972).
244. M. F. Lappert and S. Takahashi, Chem. Comm., 1272 (1972).
245. US P. 3 271 362 (1966); Chem. Abs., 65, 18 617 (1966).
246. J. F. Harrod and A. J. Chalk, J. Amer. Chem. Soc., 87, 1133 (1965).
247. A. J. Chalk and J. F. Harrod, J. Amer. Chem. Soc., 89, 1640 (1967).
248. Y. L. Baay, Diss. Abs., 28B, 2315 (1967).
249. Y. L. Baay and A. G. MacDiarmid, Inorg. Nuclear Chem. Letters, 3, 159 (1967).
250. Y. L. Baay and A. G. MacDiarmid, Inorg. Chem., 8, 986 (1969).
251. N. J. Archer, R. N. Haszeldine, and R. V. Parish, Chem. Comm., 524 (1971).
252. US P. 3 714 212 (1973); Chem. Abs., 78, 115 763 (1973).
253. Belgian P. 668 907 (1966); Chem. Abs., 65, 3906 (1966).
254. E. Ts. Chukovskaya, N. A. Kuz'mina, and M. I. Rozhkova, Zhur. Obshch. Khim., 36, 2170 (1966).
255. R. Kh. Freidlina, N. A. Kuz'mina, and E. Ts. Chukovskaya, Izv. Akad. Nauk SSSR, Ser. Khim., 176 (1966).
256. N. A. Kuz'mina, E. Ts. Chukovskaya, and R. Kh. Freidlina, Izv. Akad. Nauk SSSR, Ser. Khim., 1272 (1967).
257. K. A. Andrianov, O. M. Rad'kova, S. A. Golubtsov, and N. G. Morosov, Zhur. Obshch. Khim., 41, 1569 (1971).
258. N. G. Morozov, K. A. Andrianov, O. M. Rad'kova, A. M. Krglikov, and S. A. Golubtsov, USSR P. 192 813 (1966); Byul. Izobret. No. 6, 27 (1967).
259. P. Svoboda and J. Hetflejš, Coll. Czech. Chem. Comm., 38, 3834 (1973).
260. A. M. El-Abbady, J. Chem. U.A.R., 9, 281 (1966); Chem. Abs., 67, 48 968 (1967).
261. Dutch Appl. 6 614 931 (1967); Chem. Abs., 67, 65 239 (1967).
262. F. W. Lampe, J. S. Snyderman, and W. H. Johnston, J. Phys. Chem., 70, 3934 (1966).
263. G. Rabilloud, Bull. Soc. chim. France, 2152 (1965).
264. J. Tsurugi, R. Nakao, and T. Fukumoto, J. Amer. Chem. Soc., 91, 4587 (1969).
265. J. Tsurugi, R. Nakao, and T. Fukumoto, J. Org. Chem., 35, 833 (1970).
266. A. V. Zimin, A. D. Verina, and A. V. Gubanova, USSR P. 173 229 (1965); Byul. Izobret. No. 15, 31 (1965).
267. L. I. Kartasheva, N. S. Nametkin, and T. I. Chernysheva, Dokl. Akad. Nauk SSSR, 170, 848 (1966).
268. J. M. T. Davidson, C. Eaborn, and M. N. Lilly, J. Chem. Soc., 2624 (1964).
269. R. P. Bush, N. C. Lloyd, and C. A. Pearce, J. Chem. Soc. (A), 253 (1969).
270. J. V. Urenovitch and R. West, J. Organomet. Chem., 3, 138 (1965).
271. V. V. Koro'ko and V. O. Reikhsfel'd, Reakts. Sposobnost' Org. Soed., Tartu, 26, 98 (1965).
272. T. A. Ovchinnikova, A. I. Yakubchik, and G. Ummurti, Vestnik, Leningrad, Gos. Univ., Fiz. Khim., 3, No. 16, 114 (1971).
273. R. Kh. Freidlina and E. Ts. Chukovskaya, Dokl. Akad. Nauk SSSR, 150, 1055 (1963).

274. K. H. Linke and J. H. Göhausen, Angew. Chem., Internat. Ed., **10**, 438 (1971).
275. S. W. Bennett, C. Eaborn, and R. A. Jackson, J. Organomet. Chem., **21**, 79 (1970).
276. K. Y. Choo and P. P. Gaspar, J. Amer. Chem. Soc., **96**, 1284 (1974).
277. C. Eaborn, M. R. Harrison, and D. R. M. Walton, J. Organomet. Chem., **31**, 43 (1971).
278. P. J. Krusic and J. K. Kochi, J. Amer. Chem. Soc., **91**, 6161 (1969).
279. M. S. Wrighton and M. A. Schroeder, J. Amer. Chem. Soc., **96**, 6235 (1974).
280. P. Svoboda, R. Řeřicha, and J. Hetflejš, Coll. Czech. Chem. Comm., **39**, 1324 (1974).
281. G. V. Odabashyan and V. N. Tarasenko, Trudy Moskov. Khim.-Tekhnol. Inst. im. Mendeleeva, **61**, 60 (1969).
282. T. K. Gar, A. A. Buyakov, A. V. Kisin, and V. F. Mironov, Zhur. Obshch. Khim., **41**, 1589 (1971).
283. S. I. Sadykh-Zade, Z. B. Sultanova, and M. A. Mardanov, "Sintez i Prevrashcheniya Monomernykh Soedinenii" (The Synthesis and Reactions of Monomeric Compounds), Izd. Akad. Nauk Azerb. SSR, 1967, p. 91.
284. N. S. Nametkin, V. M. Vdovin, and T. N. Arkhipova, Dokl. Akad. Nauk SSSR, **159**, 146 (1964).
285. E. Lukevics and M. G. Voronkov, Khim. Geterotsikl. Soed., 328 (1966).
286. L. I. Kartasheva, N. S. Nametkin, and T. I. Chernysheva, Zhur. Obshch. Khim., **40**, 1262 (1970).
287. G. Greber and M. L. Hallensleben, Makromol. Chem., **83**, 148 (1965).
288. G. Greber and M. L. Hallensleben, Plaste und Kautschuk, **12**, 630 (1965).
289. G. Greber and M. L. Hallensleben, Angew. Chem., **77**, 511 (1965).
290. G. Greber and M. L. Hallensleben, Makromol. Chem., **92**, 137 (1966).
291. E. P. Lebedev, Candidate's Thesis, Lensovet Leningrad Technological Institute, Leningrad, 1968.
292. V. O. Reikhsfel'd and E. P. Lebedev, "Khimiya i Prakticheskoe Primenenie Kremniiorganicheskikh Soedinenii" (The Chemistry and Practical Applications of Organosilicon Compounds), Izd. Nauka, Leningrad, 1968, p. 137.
293. K. A. Andrianov, L. M. Khananashvili, V. M. Kopylov, and T. V. Nesterova, Izv. Akad. Nauk SSSR, Ser. Khim., 351 (1968).
294. K. A. Andrianov, L. M. Khananashvili, V. M. Kopylov, and A. A. Vyaz'minova, Izv. Akad. Nauk SSSR, Ser. Khim., 1539 (1969).
295. R. P. Bush and N. C. Lloyd, J. Chem. Soc. (A), 257 (1969).
296. W. E. Dennis and J. L. Speier, J. Org. Chem., **35**, 4180 (1970).
297. R. A. Benkeser and W. C. Muench, J. Amer. Chem. Soc., **95**, 285 (1973).
298. G. N. Koroleva, Candidate's Thesis, Lensovet Leningrad Technological Institute, Leningrad, 1967.
299. E. Lukevics, E. A. Pestunovich, V. A. Pestunovich, E. Liepins, and M. G. Voronkov, Zhur. Obshch. Khim., **41**, 1585 (1971).
300. V. A. Sokolov, A. N. Grishko, K. F. Lavrova, and G. I. Kagan, "Sintez i Svoistva Monomerov" (The Synthesis and Properties of Monomers), Izd. Nauka, Moscow, 1964, p. 153.
301. A. N. Grishko, Candidate's Thesis, Mendeleev Moscow Institute of Chemical Engineering, Moscow, 1966.
302. M. C. Musolf and J. L. Speier, J. Org. Chem., **29**, 2519 (1964).
303. E. A. Chernyshev, M. E. Dolgaya, and E. D. Lubuzh, Izv. Akad. Nauk SSSR, Ser. Khim., 650 (1965).
304. E. A. Chernyshev and M. E. Dolgaya, "Sintez i Svoistva Monomerov" (The Synthesis and Properties of Monomers), Izd. Nauka, Moscow, 1964, p. 123.
305. Z. V. Belyakova, G. M. Yakusheva, and S. A. Golubtsov, Zhur. Obshch. Khim., **34**, 1480 (1964).
306. M. Čapka, P. Svoboda, V. Bažant, and V. Chvalovsky, Chem. Prům., **21**, 324 (1971).
307. M. Kumada, K. Naka, and Y. Yamamoto, Bull. Chem. Soc. Japan, **37**, 871 (1964).
308. L. D. Nasiak, Diss. Abs., **27B**, 1820 (1966).
309. L. D. Nasiak and H. W. Post, J. Organomet. Chem., **23**, 91 (1970).
310. V. O. Reikhsfel'd, Doctoral Thesis, Lensovet Leningrad Technological Institute, Leningrad, 1967.
311. L. A. Grigor'eva, Candidate's Thesis, Lensovet Leningrad Technological Institute, 1965.
312. V. B. Pukhnarevich, S. P. Sushchinskaya, V. A. Pestunovich, and M. G. Voronkov, Zhur. Obshch. Khim., **43**, 1283 (1973).
313. V. O. Reikhsfel'd, V. B. Pukhnarevich, S. P. Sushchinskaya, and A. M. Evdokimov, Zhur. Obshch. Khim., **42**, 163 (1972).
314. M. F. Shostakovskii, S. P. Sushchinskaya, V. B. Pukhnarevich, A. I. Borisova, A. Kh. Filippova, and V. G. Sakharovskii, Izv. Akad. Nauk SSSR, Ser. Khim., 2599 (1969).
315. E. Frainnet, A. Bazouin, and R. Calas, Compt. rend., **257**, 1304 (1963).
316. J. P. Llonch and E. Frainnet, Compt. rend., **276C**, 1803 (1973).
317. I. Ojima, S. Inaba, and Y. Nagai, Tetrahedron Letters, 4363 (1973).
318. French P. 1 481 448 (1967); Chem. Abs., 68, 12 860 (1968).
319. US P. 3 466 270 (1969); Offic. Gaz., **866**, 582 (1969).
320. N. C. Cook and J. E. Lyons, J. Amer. Chem. Soc., **87**, 3283 (1965).
321. N. C. Cook and J. E. Lyons, J. Amer. Chem. Soc., **88**, 3396 (1966).
322. K. H. Linke and H. J. Göhausen, Chem. Ber., **106**, 3438 (1973).
323. A. C. Delany, R. N. Haszeldine, and A. E. Tipping, J. Chem. Soc. (C), 2537 (1968).
324. A. A. Kirpichnikova, V. G. Noskov, M. A. Sokal'skii, and M. A. Endlin, Zhur. Obshch. Khim., **43**, 1862 (1973).
325. US P. 3 354 193 (1967); Chem. Abs., 68, 22 053
326. J. Green, NASA Accession No. N65-31085, Rept. No. AD 616 649 (1965); Chem. Abs., 67, 22 641 (1967).
327. A. S. Shapatin, S. A. Golubtsov, A. A. Solov'ev, A. F. Zhigach, and V. I. Siryatskaya, Plast. Massy, No. 12, 19 (1965).
328. A. S. Shapatin, S. A. Golubtsov, A. A. Solov'ev, A. F. Zhigach, and V. I. Siryatskaya, USSR P. 166 338 (1964); Byul. Izobret., No. 22, 20 (1964).
329. A. S. Shapatin, S. A. Golubtsov, A. F. Zhigach, and V. N. Siryatskaya, "Kremniiorganicheskie Soedineniya, Trudy Soveshchaniya" (Organosilicon Compounds. Conference Proceedings), Izd. NIITEKhIM, 1968, Vol. 1, p. 68.
330. R. F. Markina, A. S. Shapatin, S. A. Golubtsov, L. D. Prigozhina, A. F. Zhigach, and V. N. Siryatskaya, "IV Konferentsiya po Khimii i Primeneniyu

Kremniiorganicheskikh Soedinenii, Tbilisi" (The IVth Conference on the Chemistry and Applications of Organosilicon Compounds, Tbilisi), 1968, p. 13.
331. US P. 3 355 478 (1967); Chem. Abs., 68, 22 504 (1968).
332. US P. 3 431 234 (1969); Chem. Abs., 70, 88 455 (1969).
333. N. N. Schwartz, E. O'Brien, S. Karlan, and M. M. Fein, Inorg. Chem., 4, 661 (1965).
334. K. P. Grinevich, A. F. Zhigach, I. G. Sarishvili, V. N. Siryatskaya, M. V. Sobolevskii, and A. A. Petrova, "IV Konferentsiya po Khimii i Primeneniyu Kremniiorganicheskikh Soedinenii, Tbilisi" (The IVth Conference on the Chemistry and Applications of Organosilicon Compounds, Tbilisi), 1968, p. 94.
335. K. P. Grinevich, A. F. Zhigach, I. G. Sarishvili, and M. V. Sobolevskii, "Kremniiorganicheskie Soedineniya. Trudy Soveshchaniya" (Organosilicon Compounds. Conference Proceedings), Izd. NIITEKhIM, Moscow, 1966, Vol. 4, p. 77.
336. US P. 3 440 260 (1969); Chem. Abs., 71, 4098 (1969).
337. N. Mayes, J. Green, and M. S. Cohen, J. Polymer Sci., 1A, 365 (1967).
338. M. V. Sobolevskii, A. F. Zhigach, K. P. Grinevich, I. G. Sarishvili, V. N. Siryatskaya, and E. M. Kozyreva, Plast. Massy, No. 1, 21 (1966).
339. E. Lukevics and M. G. Voronkov, Khim. Geterotsikl. Soed., 490 (1965).
340. E. Lukevics, Candidate's Thesis, Institute of Organic Synthesis, Academy of Sciences of Latvian SSR, Riga, 1965.
341. B. P. 1 011 578 (1965); Chem. Abs., 64, 9765 (1966).
342. French P. 1 397 043 (1965); Chem. Abs., 63, 8563 (1965).
343. French P. 1 397 044 (1965); Chem. Abs., 63, 13 316 (1965).
344. J. Lehmann and H. Schäfer, Carbohydr., Res., 16, 225 (1971).
345. J. Lehmann and H. Schäfer, Chem. Ber., 105, 969 (1972).
346. I. N. Azerbaev, K. Kalitov, K. B. Ershanov, and V. S. Bazalitskaya, USSR P. 296 752 (1969); Byul. Izobret., No. 9, 78 (1971).
347. I. N. Azerbaev, K. Kalitov, and K. B. Erzhanov, "Khimiya Atsetilena i Tekhnologiya Karbida Kal'tsiya" (The Chemistry of Acetylene and the Technology of Calcium Carbide), Izd. Kazakhstan, Alma-Ata, 1972, p. 35.
348. K. Kalitov, Candidate's Thesis, Institute of Chemical Sciences, Academy of Sciences of Kazakh SSR, Alma-Ata, 1972.
349. A. A. Dzhafarov, Candidate's Thesis, Institute of Petrochemical Processes, Academy of Sciences of Azerbaijan SSR, Baku, 1969.
350. A. M. Kuliev, A. A. Dzhafarov, and F. N. Mamedov, USSR P. 196 835 (1967); Byul. Izobret., No. 12, 35 (1967).
351. A. M. Kuliev, A. A. Dzhafarov, and F. N. Mamedov, Azerb. Khim. Zhur., No. 6, 84 (1968).
352. S. I. Sadykh Zade, R. A. Sultanov, and F. A. Gasanova, Azerb. Khim. Zhur., No. 6, 91 (1967).
353. B. P. 1 154 693 (1967); Chem. Abs., 68, 13 167 (1968).
354. US P. 3 483 241 (1969); Chem. Abs., 72, 32 010 (1970).
355. Belgian P. 628 951 (1963); Chem. Abs., 60, 16 103 (1964).
356. S. E. Alexander, R. N. Haszeldine, M. J. Newlands, and A. E. Tipping, J. Chem. Soc. (A), 2285 (1970).
357. BRD Appl. 2 055 787 (1971); Chem. Abs., 75, 77 517 (1971).
358. US P. 3 775 386 (1973); Chem. Abs., 80, 122 130 (1974).
359. US P. 3 778 430 (1973); Chem. Abs., 80, 60 026 (1974).
360. B. P. 1 321 616 (1973); Chem. Abs., 79, 105 741 (1973).
361. E. Frainnet and J. Causse, Bull. Soc. chim. France, 3034 (1968).
362. V. D. Sheludykov, V. P. Kozyukov, E. A. Rybakov, and V. F. Mironov, Zhur. Obshch. Khim., 37, 2141 (1967).
363. L. H. Sommer, Pure Appl. Chem., 19, 525 (1969).
364. L. H. Sommer, J. E. Lyons, and H. Fujimoto, J. Amer. Chem. Soc., 91, 7051 (1969).
365. E. G. Kagan, Zhur. Obshch. Khim., 37, 1962 (1967).
366. M. G. Voronkov, V. B. Pukhnarevich, S. P. Sushchinskaya, L. I. Kopylova, and B. A. Trofimov, Zhur. Obshch. Khim., 41, 2102 (1971).
367. V. B. Pukhnarevich, B. A. Trofimov, L. I. Kopylova, and M. G. Voronkov, Zhur. Obshch. Khim., 43, 2691 (1973).
368. H. M. Bank, J. C. Saam, and J. L. Speier, J. Org. Chem., 29, 792 (1964).
369. M. R. Stober, M. C. Musolf, and J. L. Speier, J. Org. Chem., 30, 1651 (1965).
370. E. Frainnet, Bull. Soc. chim. France, 792 (1963).
371. R. Tanaka, J. Iyoda, and I. Shiihara, J. Chem. Soc. Japan, Ind. Chem. Sect., 71, 923 (1968).
372. H. G. Kuivila and C. R. Warner, J. Org. Chem., 29, 2845 (1964).
373. W. R. Cullen and G. E. Styan, J. Organomet. Chem., 6, 633 (1966).
374. Z. V. Belyakova, M. G. Pomerantseva, and S. A. Golubtsov, Zhur. Obshch. Khim., 35, 1048 (1965).
375. Z. V. Belyakova, M. G. Pomerantseva, and Z. V. Belikova, Zhur. Obshch. Khim., 44, 2439 (1974).
376. T. A. Barry, F. A. Davis, and P. J. Chiesa, J. Org. Chem., 38, 838 (1973).
377. K. A. Andrianov, V. I. Sidorov, L. M. Tartakovskaya, A. I. Anpilogova, V. V. Nepomnina, and K. S. Pushchevaya, Izv. Akad. Nauk SSSR, Ser. Khim., 1118 (1971).
378. G. V. Dmitrieva, Candidate's Thesis, Irkutsk State University, Irkutsk, 1971.
379. M. F. Shostakovskii, B. A. Sokolov, G. V. Dmitrieva, and G. M. Alekseeva, Zhur. Obshch. Khim., 33, 3778 (1963).
380. M. F. Shostakovskii, B. A. Sokolov, G. V. Dmitrieva, and G. M. Alekseeva, Zhur. Obshch. Khim., 34, 2839 (1964).
381. K. A. Andrianov, L. M. Volkova, and A. A. Bogdanova, Izv. Akad. Nauk SSSR, Ser. Khim., 1405 (1970).
382. M. G. Pomerantseva, Z. V. Belyakova, S. A. Golubtsov, and L. A. Efremova, Zhur. Obshch. Khim., 40, 1089 (1970).
383. M. G. Pomerantseva, Z. V. Belyakova, S. A. Golubtsov, V. I. Zubkov, A. A. Ainshtein, and G. G. Baranova, Zhur. Obshch. Khim., 42, 862 (1972).
384. Z. V. Belyakova, M. G. Pomerantseva, and S. A. Golubtsov, Zhur. Obshch. Khim., 44, 1780 (1974).
385. Z. V. Belyakova, V. N. Bochkarev, S. A. Golubtsov, Z. V. Belikova, M. S. Yamova, A. A. Ainshtein,

G. G. Baranova, L. A. Efremova, and K. K. Popkov, Zhur. Obshch. Khim., **42**, 858 (1972).
386. K. A. Andrianov, B. G. Zavin, G. F. Sablina, L. A. Leites, B. D. Lavrukhin, and A. M. Evdokimov, Vysokomol. Soed., **16B**, 330 (1974).
387. K. I. Kobrakov, T. I. Chernysheva, L. I. Kartasheva, and N. S. Nametkin, Dokl. Akad. Nauk SSSR, **202**, 343 (1972).
388. Z. V. Belyakova, Z. V. Belikova, and M. S. Yamova, Zhur. Obshch. Khim., **41**, 1077 (1971).
389. V. F. Mironov, V. L. Kozlikov, and N. S. Fedotov, Zhur. Obshch. Khim., **41**, 1077 (1971).
390. M. G. Voronkov, N. A. Keiko, T. A. Kuznetsova, V. A. Pestunovich, L. G. Stepanova, V. V. Keiko, and E. O. Tsetlina, Zhur. Obshch. Khim., **44**, 1930 (1974).
391. C. G. Pitt and K. R. Skillern, J. Organomet. Chem., **7**, 525 (1967).
392. B. Suryanarayanan, B. W. Peace, and K. G. Mayhan, J. Organomet. Chem., **55**, 65 (1973).
393. K. Yamamoto, M. Kumada, I. Nakajima, K. Maeda, and N. Imaki, J. Organomet. Chem., **13**, 329 (1968).
394. V. L. Kozlikov, Candidate's Thesis, Moscow, 1971.
395. V. F. Mironov, V. L. Kozlikov, and N. S. Fedotov, Zhur. Obshch. Khim., **39**, 966 (1969).
396. V. F. Mironov, V. L. Kozlikov, V. P. Kozyukov, N. S. Fedotov, G. D. Khatuntsev, and V. D. Sheludyakov, Zhur. Obshch. Khim., **41**, 2470 (1971).
397. N. S. Fedotov, I. A. Luk'yanova, I. G. Rybalka, and V. F. Mironov, Zhur. Obshch. Khim., **39**, 817 (1969).
398. V. F. Mironov and N. S. Fedotov, Khim. Geterotskikl. Soed., 748 (1972).
399. V. F. Mironov, V. L. Kozlikov, N. S. Fedotov, G. D. Khatuntsev, and V. D. Sheludyakov, Zhur. Obshch. Khim., **42**, 1365 (1972).
400. V. F. Mironov, N. S. Fedotov, and V. L. Kozlikov, Khim. Geterotsikl. Soed., 221 (1969).
401. E. Frainnet, V. Martel-Siegfried, E. Brousse, and J. Dédier, J. Organomet. Chem., **85**, 297 (1975).
402. R. Bourhis and E. Frainnet, J. Organomet. Chem., **86**, 205 (1975).
403. E. Frainnet and R. Bourhis, J. Organomet. Chem., **93**, 309 (1975).
404. E. Frainnet, R. Bourhis, F. Simonin, and F. Moulines, J. Organomet. Chem., **105**, 17 (1976).
405. J. Rejhon and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 3680 (1975).
406. I. Ojima, M. Kumagai, and Y. Nagai, J. Organomet. Chem., **111**, 43 (1976).
407. J. Rejhon and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 3190 (1975).
408. J. Langová and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 420 (1975).
409. J. Langová and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 432 (1975).
410. M. Čapka and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 2073 (1975).
411. M. Capka and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 3020 (1975).
412. M. Čapka and J. Hetflejš, Coll. Czech. Chem. Comm., **40**, 3186 (1975).
413. M. Čapka and J. Hetflejš, Coll. Czech. Chem. Comm., **41**, 1024 (1976).
414. K. A. Andrianov, J. Souček, L. M. Khananashvili, and L. Ambruš, Izv. Akad. Nauk SSSR, Ser. Khim., 606 (1975).
415. J. Souček, A. A. Andrianov, L. M. Khananashvili, and V. M. Myasina, Dokl. Akad. Nauk SSSR, **222**, 128 (1975).
416. V. B. Pukhnarevich, L. I. Kopylova, B. A. Trofimov, and M. G. Voronkov, Zhur. Obshch. Khim., **45**, 89 (1975).
417. M. G. Voronkov, S. V. Kirpichenko, V. V. Keiko, L. V. Sherstyannikova, V. A. Pestunovich, and E. O. Tsetlina, Izv. Akad. Nauk SSSR, Ser. Khim., 390 (1975).
418. V. B. Pukhnarevich, L. I. Kopylova, B. A. Trofimov, and M. G. Voronkov, Zhur. Obshch. Khim., **45**, 2638 (1975).
419. L. I. Kopylova, Candidate's Thesis, Irkutsk Institute of General Chemistry, Siberian Division of the USSR Academy of Sciences, Irkutsk, 1975.
420. M. G. Voronkov, V. B. Pukhnarevich, L. I. Kopylova, V. A. Pestunovich, E. O. Tsetlina, B. A. Trofimov, I. Pola, and V. Khvalovskii, Dokl. Akad. Nauk SSSR, **227**, 91 (1976).
421. M. G. Voronkov, T. D. Barton, S. V. Kirpichenko, V. V. Keiko, and V. A. Pestunovich, Izv. Akad. Nauk SSSR, Ser. Khim., 710 (1976).
422. R. J.-P. Corriu, C. Guerin, and J. Masse, Chem. Comm., 75 (1975).
423. R. J.-P. Corriu and J. J. E. Moreau, J. Organomet. Chem., **85**, 19 (1975).
424. R. J.-P. Corriu and J. J. E. Moreau, J. Organomet. Chem., **91**, C27 (1975).
425. R. Glaser, Tetrahedron Letters, 2127 (1975).
426. H. B. Kagan, Pure Appl. Chem., **43**, 401 (1975).
427. I. Ojima and Y. Nagai, Chem. Letters, 191 (1975).
428. I. Ojima, T. Kogure, and Y. Nagai, Chem. Letters, 985 (1975).

Institute of Organic Synthesis,
Academy of Sciences of Latvian SSR,
Riga