SSCL-494

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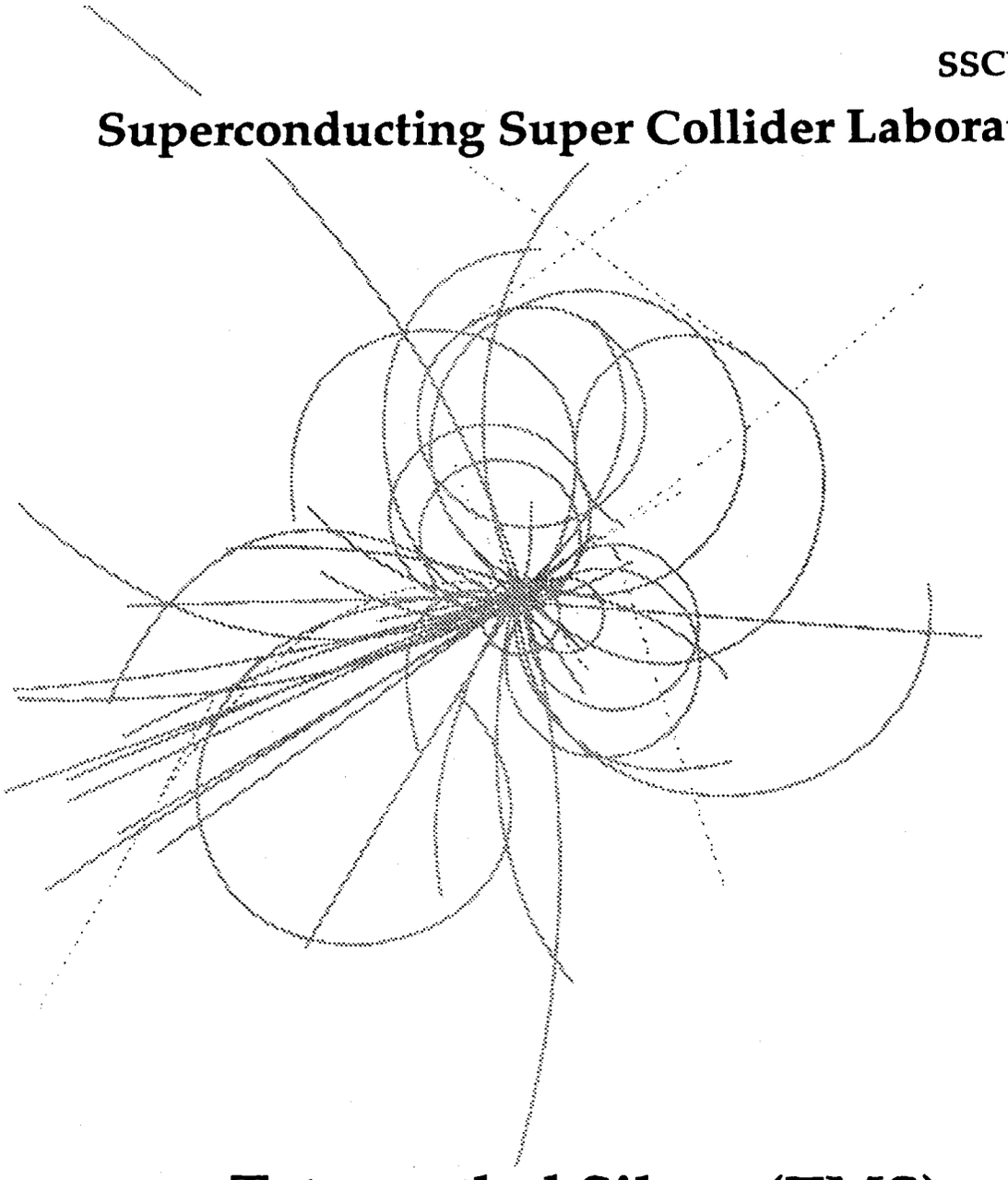
Superconducting Super Collider Laboratory



Tetramethyl Silane (TMS) Physical Properties and Safety Considerations for Use as a Calorimeter Fluid

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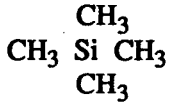
1.0 INTRODUCTION

Tetramethyl Silane, or TMS, has been proposed as a detector working fluid for the forward calorimeters of possible detectors at the Superconducting Super Collider (SSC). It has the empirical formula $C_4 H_{12} Si$ and the structure:



TMS

There is a considerable body of information and *misinformation* available about this compound. This report is intended to gather the safety-related information into one place and to point out and eliminate misconceptions encountered.

2.0 GENERAL DESCRIPTION

TMS is a volatile, flammable liquid at room temperature. It has no reported toxicity, but because of its high vapor pressure and quick evaporation, it causes cooling and damage by freezing of skin or of any part of the body that comes into contact with spilled liquid; it is particularly hazardous to the eyes. Thus it requires special handing precautions. Its properties are similar to diethyl-ether, which has been handled in hospitals and in the chemical process industry for years; thus methods for handling it exist. It does require special precautions, but it is *not* a pyrophoric material as was reported in one place, nor does it have any reported special toxic properties that would preclude its use. The toxology is incomplete, and more work probably should be developed in this area. It has been used in Nuclear Magnetic Resonance (NMR) work as a standard for many years in millions of samples run by undergraduate university students, so it is not expected to cause any major problems with human contact.

3.0 PHYSICAL PROPERTIES OF TMS

A comprehensive DIALNET survey with 419 references was conducted. What follows is an abstract of those and other results, eliminating chemical reactions and redundant references.

CHEMICAL ABSTRACTS REGISTRY NUMBER 75763
CAS RN 75-76-3, 62804-39-1, 67921-37-3
LAWSON NUMBER 3777 3793

Molecular weight 88.22 (CRC HANDBOOK OF CHEMISTRY & PHYSICS)
Boiling Point: 26.5°C (CRC), 26.6°C (Helibron act. Si-00257)

Melting Point : –102.2°C (CRC), or also listed, probably correctly, as Dimorphous solid:
–102.2°C and –99.1°C (Heilbron act. Si-00257)

Density: 0.648 g/cc at 20°C (CRC et al.)
Refractive Index: 1.3578 at 20°C (CRC)
Solubility: insoluble in water, soluble in alcohol and ether (CRC)
Clear, water white, colorless, odorless, volatile liquid
Identification number: UN2749
IMO Class: 3.1
CAS Registry: 75-76-3

Heat of Combustion calculated for the reaction: $Si(CH_3)_4 + 8O_2 = SiO_2 + 4CO_2 + 6H_2O$

$$\begin{array}{cccccc} -26 & 0 & -205 & -94.05 & -68.32 \end{array}$$

965 Kcal/mole or 29.54 MJ/l (S.W.Benson et al., Chem Rev. 69, 314 (1969))

DOT (Department of Transportation) CLASS: Flammable Liquid

4.0 FIRE AND EXPLOSION DATA

MSDS Fire and Explosion Hazards Data

Flash Point: >0°C (Helibron)

(Norell MSD sheet –18°C)

(Mallincrodt MSD Sheet –27°C)

Extinguishing media: CO_2, dry chemical, or foam (nitrogen was not included, but it is also probably satisfactory).

Explosion: above the flash point vapor-air mixtures are explosive within flammable limits (Mallincrodt).

In case of fire: wear full protective clothing and approved self-contained breathing apparatus with full facepiece and pressure-on-demand or other positive mode.

Autoignition temp in air: 450°C (843°F); spontaneous decomposition: 450°C (Ref. 2).

5.0 REACTIVITY

Stability: Stable under ordinary conditions.

Hazardous decomposition products: none (decomposes to silicon dioxide, CO_2, and H_2O).

Polymerization: will not occur.

Incompatibilities: strong acids, strong bases, heat, strong oxidizing agents.

6.0 HEALTH HAZARDS

Threshold Limit Value (TLV): none reported, but neopentane, the carbon analog, has 130,000 ppm TXDO 1 hour man.

Effects of overexposure: none reported, but based upon neopentane: headaches, tremors, drowsiness, hypnosis and anesthesia expected.

CONTACT LENSES SHOULD NOT BE WORN.

In case of contact with eyes: immediately flush eyes with plenty of water for at least 15 minutes, call physician.

In case of contact with skin: flush with plenty of water for at least 15 minutes.

If inhaled: remove to fresh air; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.

If swallowed: call physician immediately. Suggest stomach pump, avoid regurgitation. (Note: Norell MSDS gloves desirable but not required).

7.0 IN CASE OF SPILL

Ventilate. Allow evaporation with adequate ventilation.

Remove all sources of ignition.

Clean-up: personnel require protective clothing and respiratory precautions.

For protection from vapors, use boots, gloves, lab coat, apron, or coveralls. Use chemical safety goggles to protect eyes. **CONTACT LENSES SHOULD NOT BE WORN.**

Contain and recover liquid where possible. Collect all hazardous wastes and atomize in a suitable RCRA-approved combustion chamber, or adsorb with vermiculite, dry sand, earth, or similar material for disposal as hazardous waste in an RCRA-approved facility. **DO NOT FLUSH TO SEWER!**

8.0 SPECIAL STORAGE AND HANDLING REQUIREMENTS

May be shipped in 55-gal drums with special 20-ga thickness requirements to handle the vapor pressure; should be kept cool in shade below 120°F; avoid direct sunlight in summer.

9.0 SPECIAL CONSIDERATIONS FOR DETECTORS

Generally, TMS in particle detectors will tolerate less than 10 ppb oxygen level and thus must be specially processed in a purification plant and sealed against air. This level of control would usually preclude human contact and spills, except for transfer of impure material and for violent breach-of-containment accidents.

Because of the very low boiling point, the TMS probably will require refrigeration in the detector usage. Because of the flammable nature of TMS and its intolerance for oxygen, nitrogen blanketing is strongly suggested.

The unwanted presence of TMS vapor in air can easily be monitored by IR-type detectors. Transfer of the impure TMS to a purification plant might result in spills, and thus the detectors are suggested. The presence of TMS in the detector hall would indicate that something is drastically wrong, and these sensitive monitors should be able to spot trouble before it gets out of control. Remove ignition sources upon detection of traces in air.

10.0 INDUCED RADIOACTIVITY

There are also special considerations because of possible induced radioactive elements in TMS. The proton spallation process is known to create sodium-22 (Na-22 has a 2.605 yr half-life) and beryllium-7 (Be-7 has a 53.29 day half-life), as well as other isotopes when interacting with silicon. The other proposed detector materials generally are pure hydrocarbons; thus the interactions are restricted to those of hydrogen and carbon. These add tritium (H-3 with a 12.26 yr half-life) and Be-7 from C to the inventory as well. TMS has all the products from H and C, plus the added ones for Si. Neutrons also will be present, and will cause neutron activation, but to a lesser degree than the proton spallation process.

From Ref 1-LA-UR-91-999, based upon the highest possible activation levels at the worst case near the beam tube, we expect H-3, Be-8, B-12, B-13, Mg-27, Mg-28, Al-26, Al-28*, Al-29, Al-30, Si-27, and Si-31 to be significant, with Al-28 at 7×10^{-5} Ci being greatest. The rest vary downward to a selected cutoff on reporting to 10^{-9} Ci peak accumulation after a half-year's continuous running. Note that both Na-22 and Be-7 were absent from this report, and must be added to the calculation.

After one hour's downtime for cooling, only H-3, Mg-27, Mg-28, Al-28, and Si-31* persist, with Si-31 being the highest reported at 2×10^{-6} Ci remaining. (Remember the exclusion of the two isotopes above which *are* significant according to verbal reports of measurement from Fermilab and CERN, and Na-22 data obtained from the USSR.)

Because of the highly directional nature of the process, the induced radiation in the direction of the forward detector is much greater along the beam tube than further out (5°), and thus the degree of activation varies by a factor of about 1000, from low angles calculated above of less than 1° to higher angles of about 5°. The levels expected further out are such that the TMS activation will probably never be a problem,

staying below NRC/DOE radiation hazardous values even with a half-year's operation. Running this length of time without processing is not possible, because the TMS would become inoperable after about 3 to 4 months due to buildup of radiolysis chemical decomposition products. Near the beam roughly a thousandfold more radioisotopes are created, which would be mixed back from this relatively small volume into the bulk fluid. Thus the overall level would never reach the highest calculated level reported above, and the total level is a complex three-dimensional process. This has not yet been attempted; the above is a one-dimensional point model, and the real levels require a more precise calculation based upon the real three-dimensional geometry. In operation this realistically will require continual measurement.

The high luminosity at SSC and its attendant production of radioisotopes and decomposition products will cause roughly a thousandfold more contaminants and a thousandfold increase in induced radioactivity compared to CERN or Fermilab experience. Thus we must ensure that isotopes do not reach a level where we would have a "mixed waste," which is legally impermissible for us to handle. We cannot store it, process it, or ship it, so avoidance of the whole problem by never creating a mixed hazardous liquid with radioactive levels above NRC/DOE reportable levels is the only solution to the potential problem.

The TMS will require periodic cleaning to remove impurities, such as leaked oxygen from diffusion, and radiolysis products such as methane and hydrogen in any case. While this is going on, the radioactive products also can be trapped, probably adsorbed into a molecular sieve. Ion exchange resins may be classed as liquids, and thus they should probably be avoided as potentially becoming "mixed wastes" for the same reasons that creating mixed wastes is avoided for the TMS. These trapped isotopes then can be handled and shipped as a solid low-level radioactive waste after the isotopes have been removed to keep the TMS below radioactive-waste levels.

There will also be radiation-induced chemical damage, producing hydrogen, methane, and miscellaneous dimers of TMS. These radiolysis products also must not be allowed to build up, and they probably will require processing for removal roughly every 30 to 60 days. This timing depends a great deal upon specific configuration selection, the mixing of the near and far fluids, and other extrapolated factors which have not yet been determined, including some that have not been measured under the luminosity we expect. But the general trend in the order of magnitude of the buildup is clear, and the buildup and processing of intolerable impurity levels have been sufficiently estimated for the L* detector to give us confidence that this potential problem can be quantified and kept under control.

11.0 SUMMARY AND RECOMMENDATIONS

TMS will require special purification systems, some special precautions, and special handling, but no more than, for example, ether. There is nothing known at this time that would preclude its use. The physics advantages and disadvantages, the economics, and safety considerations should be weighed and compared with other options.

There is missing **TOXICITY** data which should be measured, and we should also determine by experimental measurement the explosive limits in *confined spaces*. These have been deduced by the similarity of TMS to other compounds, and we have reasonable confidence in these predictions. But the potential risk is such that we should not depend solely on similarity before committing to major investment in a TMS detector.

REFERENCES

1. W. B. Wilson, T. R. England, W. W. Kinnison, and D. M. Lee, "Calculation of the Production and Decay of Radionuclides in the Hadron Calorimeter of L* Detector for SSC," Los Alamos National Laboratory, Report No. LA-UR-91-999, March 4, 1991.
2. S. T. Griffiths and R. R. Wilson, "Spontaneous Ignition of Alkyl Silanes," *Combustion Flam.*, Vol. 2, pp. 244-252 (1958).

APPENDIX

A Literature Search of Tetramethyl Silane (TMS)
(including production, physical properties, and chemical reactions with TMS)

1696908 **tetramethyl-silane** German Chem. Name: Tetramethyl-silan CAS RN: 75-76-3, 62804-39-1, 67921-37-3 Lawson No: 3777 3793
Beilstein Cit: 5-04; 0-04-00-00625; 1-04-00-00579; 3-04-0001 843;
4-04-00-03875 Molecular Formula: C4H12Si Molecular Wt: 88.22 No. Ref: 419 Data Present:
Data Ref
+Ref Only UDF Data Type
9 2 PR Preparative Data
57 48 CR Chemical Reactions
78 137 PP Physical Properties
15 KW Short File Keywords

Preparative Data
Preparation Starting Material: SiC14, methyl magnesium bromide (Ref. 1, handbook), (Ref. 2, handbook)
Preparation Starting Material: silicium, CH31 (Ref. 3, handbook)
Preparation Starting Material: CH3+MgBr, SiC14
Reagent: diethyl ether (Ref. 4, handbook)
Preparation Starting Material: zinc dimethyl, silicium tetrachloride
Temp: 200 C (Ref. 5, handbook)
Preparation Starting Material: BN=1718732, methane, SiC14
Reagent: NH4fe(S04)2-coal
Temp: 1030 C (Ref. 6, handbook)
Preparation Starting Material: BN=1422225, tetraethyl silicate, methyl magnesium bromide
By-product: hexamethyl-disiloxane (Ref. 7, handbook)
Preparation Starting Material: BN=1209232, chloro-trimethyl-silane
Other Conditions: und das aus Dimethylsulfat und Magnesium in THF erhaltenes Reaktionsprodukt (Ref. 8, handbook)
Preparation Starting Material: BN=1209232, chloro-trimethyl-silane, methyl magnesium bromide
Reagent: dibutyl ether (Ref. 9, handbook)
Preparation Starting Material: BN=605287, dichloro-dimethyl-silane, CH3CI
Reagent: aluminium
Temp: 350 - 400 C (Ref. 10, handbook)
Preparation (Ref. 11), (Ref. 12), (Ref. 13), (Ref. 14), (Ref. 15), (Ref. 16), (Ref. 17), (Ref. 18), (Ref. 19), (Ref. 20), (Ref. 21), (Ref. 22), (Ref. 23), (Ref. 24), (Ref. 25), (Ref. 26), (Ref. 27), (Ref. 28)
Purification Method
Purification Method: (Ref. 29) Conformation
Conformation (Ref. 30) Skeletal Characteristics
Electron distribution (Ref. 31), (Ref. 32)
Interatomic distances and angles (Ref. 33, handbook), (Ref. 34, handbook)
Interatomic distances and angles (Ref. 30), (Ref. 35), (Ref. 36), (Ref. 37), (Ref. 38)
Interatomic distances and angles (Comment: Durch Elektronenbeugung ermittelter Atomabstand C-Si in gasfoermigem Tetramethylsilan: 1.93 Angstroem.) (Ref. 33, handbook)

Interatomic distances and angles (Comment: Durch Elektronenbeugung ermittelter Atomabstand C-Si in gasfoermigem Tetramethylsilan: 1.89 Angstroem.) (Ref. 34, handbook)
Interatomic distances and angles (Comment: Atomabstand C-H: 1. 10 Angstroem; Valenzwinkel Si-C-H: 110grad.) (Ref. 34, handbook)
Electrical Polarizability
Electrical Polarization
Electron polarization (Ref. 39)
Coupling Phenomena
Coupling Constants
Spin-Spin Coupling constants (Ref. 40), (Ref. 41), (Ref. 42), (Ref. 43), (Ref. 44), (Ref. 45), (Ref. 46), (Ref. 47), (Ref. 48), (Ref. 49), (Ref. 50), (Ref. 51), (Ref. 52), (Ref. 53), (Ref. 54), (Ref. 55), (Ref. 56), (Ref. 57), (Ref. 58), (Ref. 59), (Ref. 60), (Ref. 61), (Ref. 62)
Molecular Deformation & Potential
Molecular Deformation
Fundamental vibrations (Ref. 63, handbook), (Ref. 64, handbook), (Ref. 65, handbook)
Fundamental vibrations (Ref. 30), (Ref. 66)
Fundamental vibrations (Ref. 63, handbook), (Ref. 64, handbook), (Ref. 65, handbook)
Force constants (Ref. 63, handbook), (Ref. 67, handbook)
Force constants (Ref. 68), (Ref. 69), (Ref. 70), (Ref. 71)
Force constants (Ref. 63, handbook), (Ref. 67, handbook)
Energy Barrier: (Comment: Potentialschwelle der freien Drehbarkeit der Methyl-Gruppen: 1.3 kcal/Mol.) (Ref. 72, handbook), (Ref. 73, handbook)
Energy Barrier: (Ref. 74)
Energy Barrier: (Ref. 75)
Energy Barrier: (Ref. 76)
Energy Barrier: (Ref. 77)
Energy Barrier: (Ref. 78)
Energy Barrier: (Ref. 79)
Energy Barrier: (Comment: Potentialschwelle der freien Drehbarkeit der Methyl-Gruppen: 1.3 kcal/Mol.) (Ref. 72, handbook), (Ref. 73, handbook)
Molecular Energy Parameters
Molecular Energy
Bond energy (Ref. 80, handbook)
Bond energy (Ref. 81), (Ref. 82), (Ref. 83), (Ref. 84), (Ref. 85)
Bond energy (Comment: der Si-C Bindung. 72 kcal~molE-1.) (Ref. 80, handbook)
Dissociation Energy: (Ref. 86) Dissociation Energy: (Ref. 87) Dissociation Energy: (Ref. 88)
Dissociation Energy: (Ref. 89) Ionization Potential: (Ref. 90) Ionization Potential: (Ref. 91)
Ionization Potential: (Ref. 92) Ionization Potential: (Ref. 93) Ionization Potential: (Ref. 88)
Crystals
Melting Point: -102.1 C; (Comment: metastabile alphaModifikation .) (Ref. 94, handbook)
Melting Point: -100.15 C; (Ref. 95) Melting Point: -99 C; (Comment: stabile beta -Modifikation.) (Ref. 94 . handbook)
Melting Point: –91.1 C; (Ref. 96)
Melting Point: (Ref. 97)
Melting Point: (Ref. 98)
Melting Point: (Ref. 99)
Crystal Phase

Polymorphism (Ref. 100, handbook)
Polymorphism (Ref. 97)

Polymorphism (Comment: Krystallines Tetramethylsilan existiert in einer stabilen beta - Modifikation und einer metastabilen alpha -Modifikation.) (Ref. 100, handbook) Transition Point Crystalline Modificat: (Comment: Transition point (1) at: (-109° C. alpha-Modifikation in die beta -Modifikation; theoretische Umwandlungspunkt: -74grad.) (Ref. 94, handbook) Liquids Boiling Point: 23–26 C; Pressure: 760 Torr; (Ref. 16) Boiling Point: 26 C; Pressure: 760 Torr; (Ref. 11) Boiling Point: 26 C; Pressure: 760 Torr; (Ref. 101) Boiling Point: 26 C; Pressure: 760 Torr; (Ref. 23) Boiling Point: 26 C; Pressure: 760 Torr; (Ref. 20) Boiling Point: 26–27 C; Pressure: 761.4 Torr; (Ref. 4, handbook) Boiling Point: 26–27 C; Pressure: 760 Torr; (Ref. 17) Boiling Point: 26–27 C; Pressure: 760 Torr; (Ref. 21) Boiling Point: 26–27 C; Pressure: 761.4 Torr; (Ref. 4, handbook) Boiling Point: 26.5 C; Pressure: 760 Torr; (Ref. 29) Boiling Point: 26.5 C; Pressure: 760 Torr; (Ref. 102) Boiling Point: 26.5–27 C; Pressure: 760 Torr; (Ref. 15) Boiling Point: 26.54 C; Pressure: 760 Torr; (Ref. 100, handbook) Boiling Point: 26.6 C; Pressure: 760 Torr; (Ref. 103) Boiling Point: 30–31 C; Pressure: 760 Torr; (Ref. 5, handbook) Boiling Point ~ 5 C; Pressure: 200 Torr; (Ref. 12) Radial distribution function (Ref. 30) Gases Critical Temp: (Ref. 104) Critical Temp: (Ref. 105) Critical Pressure: (Ref. 104) Critical Pressure: (Ref. 105) Critical Density: (Ref. 106) Critical Volume: (Ref. 105) Vapor Pressure: 6.2–588.5 Torr; Temp: –64.2–19.5 C; (Ref. 73, handbook), (Ref. 107, handbook) Vapor Pressure: (Ref. 108) Vapor Pressure: (Ref. 104) Vapor Pressure: (Ref. 105) Vapor Pressure: (Ref. 109) Other Physical & Mechanical Properties Density: 0.6373 g/cm~3; Measurement Temp: 25 C; (Ref. 110) Density: 0.642 g/cm~3; Ref Temp: 4 C; Measurement Temp: 20 C; (Ref. 1 6)

Density: 0.645 g/cm~3; Ref Temp: 4 C; Measurement Temp: 20 C; (Ref. 1 02)

Density: 0.6462 g/cm~3; Ref Temp: 4 C; Measurement Temp: 20 C; (Ref. 1 5)

Density: 0.648 g/cm~3; Ref Temp: 4 C; Measurement Temp: 18.7 C; (Ref. 4, handbook)

Density: 0.6482 g/cm~3; Ref Temp: 4 C; Measurement Temp: 20 C; (Ref.23)

Density: 0.6495 g/cm~3; Ref Temp: 4 C; Measurement Temp: 10 C; (Ref. 111, handbook)

Density: 0.651 g/cm~*3; Ref Temp: 4 C; Measurement Temp: 15 C; (Ref. 4, handbook)

Density: 0.6674 g/cm~3; Measurement Temp: O C; (Ref. 4, handbook)

Density: 0.6698 g/cm~3; Ref Temp: 4 C; Measurement Temp: 20 C; (Ref. 1 7)

Molar Volume: (Ref. 112)

Mechanical Properties Virial coefficients of the equation of state (Ref. 74), (Ref. 75), (Ref. 113)

Surface Tension: 12.85 g/sec~2; Temp: 20 C; (Ref. 114, handbook) Self-Diffusion & Thermal Conductivity

Self-diffusion: (Ref. 115)
Self-diffusion: (Ref. 116)
Self-diffusion: (Ref. 117)
Self-diffusion: (Ref. 112) Calorific Data
Enthalpy of Melting: 5973.7 J/mol; (Ref. 94, handbook)
Enthalpy of Melting: 6899.8 J/mol; (Ref. 94, handbook)
Enthalpy of Melting: (Ref. 97)

Calorific Data Entropy of melting (Ref. 97) Enthalpy (Ref. 118), (Ref. 119)

Enthalpy of Vaporization: 26167 J/mol; (Comment: enthalpy of vaporization:beim Siedepunkt.) (Ref. 120, handbook)

Enthalpy of Vaporization: (Ref. 73, handbook)

Refractive Index: 1.3587; Wavelength: 589 nm; Temp: 20 C; (Ref. 1 29, handbook)

Refractive Index: 1.3588; Wavelength: 589 nm; Temp: 20 C; (Ref. 1 30, handbook)
Refractive Index: 1.359; Wavelength: 589 nm; Temp: 20 C; (Ref. 17)
Refractive Index: 1.3591; Wavelength: 589 nm; Temp: 18.7 C; (Ref. handbook)
Refractive Index: 1.3595; Wavelength: 589 nm; Temp: 20 C; (Ref. 23)
Refractive Index: 1.3605; Wavelength: 546.1 nm; Temp: 20 C; (Ref. 1 30, handbook)
Refractive Index: 1.3645; Wavelength: 486.1 nm; Temp: 18.7 C; (Ref. handbook)
Refractive Index: 1.3648; Wavelength: 589 nm; Temp: 10 C; (Ref. 1 1 1, handbook)
Refractive Index: 1.3681; Wavelength: 435.8 nm; Temp: 20 C; (Ref. 1 30, handbook)
Refractive Index: 1.3689; Wavelength: 434 nm; Temp: 18.7 C; (Ref. handbook)
Magnetic birefringence (Cotton-Mouton Effect) (Ref. 131)
Electric birefringence (Kerr Effect) (Ref. 131)
Rayleigh scattering (Ref. 132)
Degree of depolarization of Rayleigh scatt. (Ref. 133) Spectra Data NMR Spectrum
(Ref. 41)
(Ref. 134)
(Ref. 135)
NMR Absorption Nucleus: 1H; (Ref. 136, handbook) Nucleus: 13C; (Ref. 137, handbook)
Nucleus: 29Si; (Ref. 138, handbook) (Ref. 139) (Ref. 140) (Ref. 141)
Heat Capacity
cp: 2.22–137.33 J/(mol~deg); Temp: –262.1 – –103.1 C; (Ref. 94, handbook)
cp: 154.91 J/(mol~deg); Temp: –105.5 C; (Ref. 94, handbook)
cp: 164.54–198.04 J/(mol~deg); Temp: –93.1 – 16.9 C; (Ref. 73, handbook)
cp: 199.29 J/(mol~deg); Temp: –103.9 C; (Ref. 94, handbook)
cp: (Ref. 97)
cp: (Ref. 121)

Entropy & Enthalpy
Entropy Delta S: (Comment: des Gases bei Siedepunkt.) (Ref. 73, handbook)
Entropy Delta S: (Ref. 118)
Entropy Delta S: (Comment: des Gases bei Siedepunkt.) (Ref. 73, handbook)
Enthalpy of Formation: –138160 J/mol; (Comment: Standard.) (Ref. 1 22, handbook)
Enthalpy of Formation: (Ref. 123)
Enthalpy of Formation: (Ref. 124)
Enthalpy of Formation: (Ref. 125)
Enthalpy of Formation: (Ref. 82)
Enthalpy of Formation: (Ref. 126)
Enthalpy of Combustion: –3851900 J/mol; (Comment: Standard.)
(Ref. 1 20, handbook), (Ref. 127, handbook)
Enthalpy of Combustion: (Ref. 83)

Optical Properties
Refractive Index: 1.343; Wavelength: 589 nm; Temp: 20 C; (Ref. 15)
Refractive Index: 1.3478; Wavelength: 589 nm; Temp: 20 C; (Ref. 1 02)
Refractive Index: 1.3515; Wavelength: 589 nm; Temp: 30 C; (Ref. 1 28)
Refractive Index: 1.3569; Wavelength: 656.3 nm; Temp: 18.7 C; (Ref. handbook)
Refractive Index: 1.3575; Wavelength: 589 nm; Temp: 20 C; (Ref. 1 6)
Refractive Index: 1.3587; Wavelength: 589 nm; Temp: 20 C; (Ref. 1 29, handbook)
Refractive Index: 1.3587; Wavelength: 589 nm; Temp: 20 C; (Ref. 27)

(Ref. 142) (Ref. 143) (Ref. 144) (Ref. 145) (Ref. 146) (Ref. 48) (Ref. 49) (Ref. 147) (Ref. 148) (Ref. 149)

NMR Data

Spin-lattice relaxation time T1 (Ref. 46), (Ref. 150), (Ref. 151) INDOR (Ref. 148) NOE (Ref. 152), (Ref. 153)

ESR Data g-Factor (Ref. 154) Vibrational Spectra IR Spectrum Wavenumber: 5000–625 cm~-1; Solvent: CC14; (Ref. 155, handbook)
Wavenumber: 5000 - 1000 cm~-1; Solvent: CC14; (Ref. 156, handbook)
Wavenumber: 5000 - 625 cm~-1; Solvent: CC14; (Ref. 155, handbook)
Wavenumber: 5000 - 1000 cm~-1; Solvent: CC14; (Ref. 156, handbook)
Wavenumber: 1400 - 700 cm~-1; Solvent: neat (no solvent); (Comment: fester,fluessiger,gasfoermiger.) (Ref. 157, handbook)
Wavenumber: 3400 - 600 cm~-1; Solvent: neat (no solvent); (Comment: gasfoermiger.) (Ref. 65, handbook)
Wavenumber: 5000 - 625 cm~-1; Solvent: neat (no solvent); (Comment: gasfoermiger.) (Ref. 158, handbook)
Wavenumber: 3333 - 667 cm~-1; (Comment: des Gases.) (Ref. 1 5 9, handbook), (Ref. 160, handbook) Wavenumber: 10000 - 667 cm~-1; (Comment: des Gases.) (Ref. 10 0, handbook)
IR Bands
(Ref. 161) (Ref. 162) (Ref. 163)

Vibrational Spectrum Intensity of IR bands (Ref. 164)

Raman-spectrum: (Ref. 160, handbook), (Ref. 165, handbook), (Ref. 166, handbook), (Ref. 167, handbook) (Ref. 168) (Ref. 169) (Ref. 160, handbook), (Ref. 165, handbook), (Ref. 166, handbook), (Ref. 167, handbook)

Raman-bands: gasfoermiger (Ref. 170, handbook) 3000-200 cmE-1 (Ref. 65, handbook), (Ref. 171, handbook),
(Ref. 172, handbook), (Ref. 173, handbook)

Electronic Spectra

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Emission Spectra

Emission spectrum Quantum yield of emission (Ref. 118) Emission quenching (Ref. 175)

Other Spectra

Other Spectroscopic Methods Photoelectron spectrum (Ref. 90), (Ref. 93), (Ref. 176), (Ref. 177), (Ref. 178), (Ref. 179) ESCA (Ref. 180) Appearance potential (Ref. 82), (Ref. 181), (Ref. 182), (Ref.1 83)

Mass Spectrum Method: Elektronenstoss; (Ref. 184, handbook) (Ref. 185) (Ref. 186) (Ref. 187) (Ref. 188) (Ref. 123) (Ref. 181) (Ref. 189)

Magnetic Properties

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Static Dielectric Constant: 1.921; Temp: 20 C; (Ref. 130, handbook)
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Solubility: (Ref. 194) Liquid/Solid System

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Vapour pressure diagram for the mixture (Ref. 108), (Ref. 195), (Ref. 196)
Critical data for mixtures (Ref. 109)
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Adsorption
adsorption (Ref. 205)
Adsorption isotherm (Ref. 206) Association
Spectrum (e.g., UV, lR, NMR,) of the complex (Ref. 207), (Ref. 208) Chemical Reactions
Chemical Reaction: Partner: SiC14, AIC13

Temp: 290–325 C
Reaction Product: chloro-trimethyl-silane, dichloro-dimethylsilane (Ref. 209, handbook)
Chemical Reaction:
Partner: chlorine, tert-butylbenzene, CS2 Temp: 25 C
Further Conditions: im Gluehlampenlicht; relative. Irradiation
Aim of the Study: Reactivity (Ref. 210, handbook)
Chemical Reaction:
Partner: chlorine, carbon tetrachloride, PC15
Reaction Product: trimethyl-chloromethyl-silane (Ref. 1, handbook)
Chemical Reaction: Partner: chlorine
Temp: 25 C
Further Conditions: im Gluehlampenlicht; relative. Irradiation
Aim of the Study: Reactivity (Ref. 210, handbook)
Chemical Reaction:
Partner: nitrogen
Temp: 28 C
Further Conditions: durch elektrische Entladungen aktivierter (Ref. 211, handbook)
Chemical Reaction:
Partner: nitrogen
Temp: 250 C
Further Conditions: durch elektrische Entladungen aktivierter (Ref. 211, handbook)
Chemical Reaction:
Partner: nitrogen
Temp: 28 C
Further Conditions: durch elektrische Entladungen aktivierter (Ref. 211, handbook)
Chemical Reaction:
Partner: nitrogen
Temp: 250 C

Further Conditions: durch elektrische Entladungen aktivierter (Ref. 211, handbook)
Chemical Reaction: Temp: 659 C
Further Conditions: thermische Zersetzung (Ref. 212, handbook) Chemical Reaction: Temp: 689 C
Further Conditions: thermische Zersetzung (Ref. 212, handbook) Chemical Reaction: Temp: 720 C
Pressure: 100–200 Torr
Further Conditions: thermische Zersetzung (Ref. 213, handbook) Chemical Reaction: Temp: 720 C
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1. Whitmore, Sommer, JACSAT, J.Amer.Chem.Soc., 68(1946)483
2. Aston, Kennedy, Messerly, JACSAT, J.Amer.Chem.Soc., 63(1941)2343
3. Okawara, Sakiyama, BCSJA8, Bull.Chem.Soc.Jpn., 29(1958)236
4. Bygden, CHBEAM, Chem.Ber., 44 (1911),2642,2651, ZEPCAC, Z.Phys.Chem. Stoechiom.Verwandtschaftsl., 90 (1915),246
5. Friedel, Crafts, LACHDL, Liebigs Ann.Chem., 136 (1865),203
6. Plax Corp, US 2405019, (1943)
7. Sommer, Whitmore, JACSAT, J.Amer.Chem.Soc., 77(1955)6647
8. Normant, Perrin, BSCFAS, Bull.Soc.Chim.Fr., (1957) 801
9. Zemany, Price, JACSAT, J.Amer.Chem.Soc., 70(1948)4222
10. Beranek, Bazant, CCCCAK, Collect.Czech.Chem.Commun., 22(1957)1293,1300
11. Th Goldschmidt, DE 1239687, (1965), CA 68(1968)29899
12. General Electric Co, US 3099671, (1955), CA 60(1964)553c
13. Glockling, Sweeney, JRMPDM, J.Chem.Res.Miniprint, (1977)061 5,061 9
14. Dolgoplosk, et al, DKCHAY, Dokl.Chem.(Engl.Transl.), 223-225(1975)501, 223
15. Zakharkin, et al, TETRAB, Tetrahedron, 21(1965)881,886
16. Andreew, Kucharskaja, DANKAS, Dokl.Akad.Nauk SSSR,1 34(1960)89,91
17. Dolgow, et al, JGCHA4, J.Gen.Chem.USSR (Engl.Transl.), 30(1960)2960, ZOKHA4, Zh.Obshch.Khim., 30(1960)2988
18. Connolly, Urry, JOCEAH, J.Org.Chem., 29(1964)619,621, 622
19. Dolgoplosk, et al, JORCAI, J.Organomet.Chem., 128(1977)339,340,344
20. Mueller, Reichel, CHBEAM, Chem.Ber., 99(1966)792,798
21. Ishikawa, et al, JORCAI, J.Organomet.Chem., 23(1970)63
22. Cabiddu, et al, GCITA9, Gazz.Chim.Ital., 101(1971)512
23. Wdowin, et al, IASKA6, Izv.Akad.Nauk SSSR Ser.Khim., (1961)281
24. Morrison, Jagow, INOCAJ, Inorg.Chem., 16(1977)2972
25. Hase, Simons, JCPSA6, J.Chem.Phys., 52(1970)4004
26. Groschwitz, et al, JORCAI, J.Organomet.Chem., 9(1967)421,422
27. Szekely, et al, ABRCAW, Ann.Univ.Sci.Budap.Rolando Eotvos Nominatae Sect.Chim., 6(1964)103,104-106, CA 62(1965)1471 8h
28. Mobil Oil Corp, US 3384652, (1964), CA 69(1968)59364z
29. Fritz, Ksinsik, ZAACAB, Z.Anorg.Allg.Chem., 304(1960)241
30. Beagley, et al, JMOSB4, J.Mol.Struct., 8(1971)401
31. Kestner, Jortner, JCPSA6, J.Chem.Phys., 59(1973)26,27
32. Schiller, JCPSA6, J.Chem.Phys., 57(1972)2222
33. Brockway, Jenkins, JACSAT, J.Amer.Chem.Soc., 58(1936)2037
34. Sheehan, Schomaker, JACSAT, J.Amer.Chem.Soc., 74(1952)3956
35. Mastryukov, et al, JSTCAM, J.Struct.Chem.(Engl.Transl.),17(1976)69 ,71
36. Pierce, Petersen, JCPSA6, J.Chem.Phys., 33(1960)907,211
37. Bovey, JCPSA6, J.Chem.Phys., 32(1960)1877
38. Schmidbaur, CH BEAM, Chem. Ber., 97(1964)1639, 1642-1644
39. Schmidt, Allen, JCPSA6, J.Chem.Phys., 52(1970)4788,4790
40. Servis, et al, JPCHAX, J.Phys.Chem., 74(1970)3960
41. Dean, McFarlane, MOPHAM, Mol.Phys., 12(1967)289,364 Erratum
42. McLaughlan, MOPHAM, Mol.Phys., 11(1966)303
43. Schmidbaur, Hussek, JORCAI, J.Organomet.Chem., 1 (1964)245,249
44. Lazlo, Speert, JOMRA4, J.Magn.Reson., 1(1969)291,292
45. Lunazzi, Taddei, BSFCAY, Boll.Sci.Fac.Chim.Ind.Bologna, 23(1965)359,361
46. Harris, Kimber, JOMRA4, J.Magn.Reson., 17(1975)174,175, 176

47. Engelhardt, JORCAI, J.Organomet.Chem., 8(1967)P27
48. Ebsworth, Frankiss, TFSOA4, Trans.Faraday Soc.,63(1967)1574, 1 575
49. Hammel, Smith, JCSIAP, J.Chem.Soc.A, (1970)1852
50. Smith, JCPSA6, J.Chem.Phys., 39(1963)2031
51. Juan, Gutowsky, JCPSA6, J.Chem.Phys., 37(1962)2198,2201
52. Dreeskamp, ZPCFAX, Z.Phys.Chem.(Munich), 38(1963)121
53. Lacey, et al, AJCHAS, Aust.J.Chem., 23(1970)1421,1424
54. Jameson, Gutowsky, JCPSA6, J.Chem.Phys., 51 (1969)2790,2800
55. Dreeskamp, ZPCFAX, Z.Phys.Chem.(Munich), 59(1968)321
56. Schmidbaur, JACSAT, J.Amer.Chem.Soc., 85(1963)2336
57. Muller, JCPSA6, J.Chem.Phys., 36(1962)359,362
58. Drago, Matwiyoff, JORCAI, J.Organomet.Chem., 3(1965)62,64
59. Szalmona, MOPHAM, Mol.Phys., 7(1963-1964)497
60. Laszlo, BSCFAS, Bull.Soc.Chim.Fr., (1966)558,565
61. West, et al, JORCAI, J.Organomet.Chem., 8(1967)79,82
62. Levy, et al, JOMRA4, J.Magn.Reson., 8(1972)280
63. Kowalew, OPSPAM, Opt.Spektrosk., 6(1959)594;engl.Ausg.S.387
64. Forneris, Funck, ZEAPAA, Z.Elektrochem.Angew.Phys.Chem., 62(1958)1 130, 1135
65. Shull, et al, JCPSA6, J.Chem.Phys., 21(1953)2024,2027
66. Creighton, et al, AJCHAS, Aust.J.Chem., 20(1965)583,585, 586
67. Sheline, JCPSA6, J.Chem.Phys., 18(1950)602,605
68. Watari, SAMCAS, Spectrochim.Acta Part A, 34(1978)1239,1240, 1 243
69. Kaila, et al, BSCBAG, Bull.Soc.Chim.Belg., 87(1978)93,102
70. Radhakrishnan, ZPCFAX, Z.Phys.Chem.(Munich), 35(1 962)247,251
71. Kovalev, SPHDA9, Sov.Phys.Dokl.(Engl.Transl.), 5(1961)1019, DANKAS, Dokl.Akad.Nauk SSSR, 134(1960)559
72. Aston, Kennedy, JACSAT, J.Amer.Chem.Soc., 62(1940)2567
73. Aston, Kennedy, Messerly, JACSAT, J.Amer.Chem.Soc., 63(1941)2343,2347
74. Bottomley, Nairnn, AJCHAS, Aust.J.Chem., 30(1977)1645,1650
75. De Rocco, Hoover, JCPSA6, J.Chem.Phys., 36(1962)916,918, 9 2 1
76. During, et al, JCPSA6, J.Chem.Phys., 52(1970)2046,2047, 2050
77. Kovalev, SPHDA9, Sov.Phys.Dokl.(Engl.Transl.), 7(1962)127, DANKAS, Dokl.Akad.Nauk SSSR, 142(1962)1069
78. Kovalev, SPHDA9, Sov.Phys.Dokl.(Engl.Transl.), 8(1963)74, DANKAS, Dokl.Akad.Nauk SSSR, 148(1963)569
79. Kovalev, SPHDA9, Sov.Phys.Dokl.(Engl.Transl.), 6(1961)146, DANKAS, Dokl.Akad.Nauk SSSR, 136(1961)1313
80. Batuew, et al, ZOKHA4, Zh.Obshch.Khim., 26(1956)2336,2341 ;engl.Ausg.S.2613,261 8
81. Avansino, et al, INOCAJ, Inorg.Chem., 14(1975)1595
82. Lappert, et al, JORCAI, J.Organomet.Chem., 29(1971)1 95,1 99,205
83. Lautsch, WZHLDE, Wiss.Z.Tech.Hochsch.Carl Schorlemmer Leuna-Merseburg, 6(1964)282
84. Drake, et al, INOCAJ, Inorg.Chem., 17(1978)2333
85. Sanderson, JINCAO, J.lnorg.Nucl.Chem., 28(1966)1553,1561
86. Kerr, et al, IJCKBO, Int.J.Chem.Kinet., 1(1969)339,350
87. Doncaster, Walsh, JCFTAR, J.Chem.Soc.Faraday Trans.1, 72(1976)2908
88. Lappert, et al, JORCAI, J.Organomet.Chem., 17(1969)P1,P2
89. Davidson, Stephenson, JCSIAP, J.Chem.Soc.A, (1968)282
90. Green, et al, JORCAI, J.Organomet.Chem., 31(1971)C55
91. Pitt, JACSAT, J.Amer.Chem.Soc., 91(1969)6613,6614

92. Schmidt, et al, ZENAAU, Z.Naturforsch.A Astrophys.Phys.Phys.Chem., 33(1978)1 393
93. Evans, et al, JCFTBS, J.Chem.Soc.Faraday Trans.2, 68(1972)905
94. Aston, Kennedy, Messerly, JACSAT, J.Amer.Chem.Soc., 63(1941)2343,2346
95. Smith, JCPSA6, J.Chem.Phys., 42(1965)4229,4230
96. Liu, Lagow, JORCAI, J.Organomet.Chem., 145(1978)167,171, 1 72
97. Haradu, et al, JCTDAF, J.Chem.Thermodynamics, 9(1977)523,526-529
98. Bullot, Gauthier, CHPLBC, Chem.Phys.Lett., 40(1976)402
99. van Loef, JCPSA6, J.Chem.Phys., 61(1974)1605
100. Young, Koehler, McKinney, JACSAT, J.Amer.Chem.Soc., 69(1947)1 41 1
101. Dynamit Nobel AG, DE 2708406, (1978), CA 89180152
102. Petrow, et al, JGCHA4, J.Gen.Chem.USSR (Engl.Transl.), (1960)252, ZOKHA4, Zh.Obshch.Khim., 30(1960)235, CA (1960)22436
103. Wurst, Churacek, CCCCAK, Collect.Czech.Chem.Commun., 36 (1971) 3497,3500
104. McGlashan, McKinnon, JCTDAF, J.Chem.Thermodynamics, 9(1977)1205, 121 0
105. McGlashan, McKinnon, JCTDAF, J.Chem.Thermodynamics, 9(1977)1205,1211,1 21 2
106. McLure, et al., JCTDAF, J.Chem.Thermodynamics, 9(1 977)957,958
107. Tannenbaum, Kaye, Lewenz, JACSAT, J.Amer.Chem.Soc., 75(1953)3756
108. Brewster, McGlashan, JCTDAF, J.Chem.Thermodynamics, 9(1977)1095, 1097
109. Hicks, Xoung, JCFTAR, J.Chem.Soc.Faraday Trans.1, 72(1976) 122,125,126
110. Lister, Marson, CJCHAG, Can.J.Chem., 42(1964)2101,2103
111. Fleming, Aston bei Sauer, JACSAT, J.Amer.Chem.Soc., 68(1946)956
112. van Loef, JCFTAR, J.Chem.Soc.Faraday Trans.1, 75(1979)2060,2062
113. Dymond, et al, JCPSA6, J.Chem.Phys., 42(1965)2801,2804
114. Mills, MacKenzie, JACSAT, J.Amer.Chem.Soc., 76(1954)2672
115. Van Loef, Physica (Utrecht) B, 95(1978)34
116. Parkhurst, Jonas, JCPSA6, J.Chem.Phys., 63(1975)2698
117. Douglass, et al, JCPSA6, J.Chem.Phys., 34(1961)152,153
118. Golosova, et al, RJPCAR, Russ.J.Phys.Chem. (Engl.Transl.), 45(1971)759
119. Goodloe, Lampe, JACSAT, J.Amer.Chem.Soc., 101(1979)6028,6029, 6030
120. Tannenbaum, et al, JACSAT, J.Amer.Chem.Soc., 75(1953)3754
121. Shinoda, et al, BCSJA8, Bull.Chem.Soc.Jpn., 46(1973)48
122. Telnoi, Rabinowitsch, ZFKHA9, Zh.Fiz.Khim., 39(1965)2076;engl.Ausg.S.11 08
123. Patzinger, Lampe, JPCHAX, J.Phys.Chem., 74(1970)719
124. Dillard, INOCAJ, Inorg.Chem., 13(1974)1491
125. van Dalen, van den Berg, JORCAI, J.Organomet.Chem., 24(1970)277,278
126. Tel'noi, Rabinovich, RJPCAR, Russ.J.Phys.Chem. (Engl.Transl.), 39(1965)1 1 08
127. Lautsch, CHTEDD, CHEMTECH, 10(1958)419
128. Rummens, JCPBAN, J.Chim.Phys.Phys.Chim.Biol., 72 (1975)448 ,450
129. Sommer, Mitarb, JACSAT, J.Amer.Chem.Soc., 68(1946)1084
130. Altshuller, Rosenblum, JACSAT, J.Amer.Chem.Soc., 77 (1955) 272
131. Battaglia, CHPLBC, Chem.Phys.Lett., 54(1978)124,126
132. Gornall, et al, PLRAAN, Phys.Rev.A, 1(1970)3-1288
133. Carlson, Flory, JCFTBS, J.Chem.Soc.Faraday Trans.2, 73(1977)1505, 1513
134. Schmidbaur, CHBEAM, Chem.Ber., 98(1965)83,89
135. Schmidbaur, Schmidt, ANCEAD, Angew.Chem., 74(1962)327
136. Schnell, Rochow, JINCAO, J.Inorg.Nucl.Chem., 6(1958)303,305
137. Lauterbur, JCPSA6, J.Chem.Phys., 26(1957)217, ANYAA9, Ann.N.Y.Acad.Sci., 70(1958)841,846
138. Holzman, et al, JCPSA6, J.Chem.Phys., 25(1956)172

139. Becconsall, MOPHAM, Mol.Phys., 15(1968)129,135
140. Weiner, Malinowski, JPCHAX, J.Phys.Chem., 75(1971)1207
141. Ziessow, Carroll, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 76(1 972)61
142. Pestunovich, et al, TEXCAK, Theor.Exp.Chem.(Engl.Transl.), 4(1 968)425
143. Jameson, Jameson, JACSAT, J.Amer.Chem.Soc., 95(1973)8559
144. Laszlo, et al, JCPSA6, J.Chem.Phys., 48(1968)1732,1733
145. Friedrich, ZENBAX, Z.Naturforsch.B Anorg.Chem.Org.Chem.Biochem.Biophys.Biol., 19(1964)663
146. Petrakis, Sederholm, JCPSA6, J.Chem.Phys., 3 5 (1961) 1 174, 1 175
147. Levy, et al, JOMRA4, J.Magn.Reson., 11(1973)352
148. Bahbuch, et al, MUCBBG, Moscow Univ.Chem.Bull.(Engl.Transl.), 344(1979)69
149. Malinowski, Werner, JACSAT, J.Amer.Chem.Soc., 92(1970)41 93
150. Heatley, JCFTBS, J.Chem.Soc.Faraday Trans.2, 70 (1974)148, 161
151. Moniz, et al, JCPSA6, J.Chem.Phys., 38(1963)2418,2422, 2423
152. Farrar, et al, JACSAT, J.Amer.Chem.Soc., 94(1972)699
153. Levy, et al, JACSAT, J.Amer.Chem.Soc., 95(1963)3445,3447
154. Schmidt, Allen, JCPSA6, J.Chem.Phys., 52(1970)2345,2348
155. Kage, Tannenbaum, JOCEAH, J.Org.Chem., 18(1953)1750,1751
156. Kreschkow, et al, ZAKHA8, Zh.Anal.Khim., 9(1954)208,211 ;engl .Ausg.S.23 1,235
157. Simon, McMahon, JCPSA6, J.Chem.Phys., 20(1952)905
158. Smith, JCPSA6, J.Chem.Phys., 21(1953)1997,2003
159. Sheppard, Simpson, Sutherland, DFSOAW, Discuss.Faraday Soc., 9(1950)21 6
160. Rank, Saksena, Shull, DFSOAW, Discuss.Faraday Soc., 9(1950)1 90,1 92
161. Licht, et al, ZAACAB, Z.Anorg.Allg.Chem., 415(1975)31,37
162. Buerger, Biedermann, SAMCAS, Spectrochim.Acta Part A, 28(1972)2283
163. Shimizu, Murata, JMOSA3, J.Mol.Spectrosc., 5(1960)44
164. Tikhomirova, et al, OPSUA3, Opt.Spectros.(Engl.Transl.), 27(1969)334
165. Silver, JCPSA6, J.Chem.Phys., 8(1940)931
166. Wall, Eddy, JCPSA6, J.Chem.Phys., 6(1938)107
167. Rank, Bordner, JCPSA6, J.Chem.Phys., 3(1935)249
168. Jones, et al, JOCEAH, J.Org.Chem., 30(1965)1822,1831
169. Shinoda, BCSJA8, Bull.Chem.Soc.Jpn., 50(1977)1382
170. Waters, Woodward, PRLMZ, Proc.R.Soc.London A, 246(1958)119,1 23,1 25
171. Shimanouchi, JCPSA6, J.Chem.Phys., 18(1950)1306
172. Batuew, et al, IASKA6, Izv.Akad.Nauk SSSR Ser.Khim., (1958) 996,998; engl.Ausg.S.966,968
173. Kolesowa, et al, IASKA6, Izv.Akad.Nauk SSSR Ser.Khim., (1953) 294;engl .Ausg .S.267
174. Petukhov, et al, JGCHA4, J.Gen.Chem.USSR (Engl.Transl.), 49(1979)91 6
175. Yarwood, et al, JCPSA6, J.Chem.Phys., 41(1964)1705,1711
176. Boschi, et al, JORCAI, J.Organomet.Chem., 50(1973)69
177. Roberge, et al, JCPSA6, J.Chem.Phys., 69(1978)5105
178. Perry, Jolly, CHPLBC, Chem.Phys.Lett., 17(1972)611
179. Bock, Eusslin, ANCEAD, Angew.Chem., 12(1971)435
180. Drake, et al, CJCHAG, Can.J.Chem., 53(1975)3602,3603
181. Potzinger, et al, Z. Naturf. A, 30(1975)347,350,352
182. Band, et al, JCSIAP, J.Chem.Soc.A, (1968)2068
183. Hess, et al, JACSAT, J.Amer.Chem.Soc., 86(1964)3174
184. Dibeler, JRNBAG, J.Res.Natl.Bur.Stand.(U.S.), 49(1952)235,236
185. Orlov, HIECAP, High Energy Chem.(Engl.Transl.), 11(1977)1 85,1 87

186. Potzinger, Lampe, JPCHAX, J.Phys.Chem., 75(1971)13,14
187. Klevan, Munson, IJMIBY, Int.J.Mass Spectrom.lon Phys., 13(1974)261 ,262-265
188. Dimmel, et al, JOCEAH, J.Org.Chem., 37(1972)2665,2666
189. Odiorne, et al, JPCHAX, J.Phys.Chem., 76(1972)3217
190. Abel, et al, TFSOA4, Trans.Faraday Soc., 60(1964)1214,1215
191. Abel, Bush, TFSOA4, Trans.Faraday Soc., 59(1963)630
192. Buck, et al, MOPHAM, Mol.Phys., 35(1978)65,75,76
193. Prausnitz, Benson, AICEAC, AIChEJ, 5(1959)301,302, 303, CA (1962)2940
194. De Ligny, van der Veen, RTCPA3, Recl.Trav.Chim.Pays-Bas, 90(1971)984
195. Hoepfner, et al, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 74(1970)1 01 6
196. Kreibich, et al, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 74(1970)1020, 1021-1024
197. Bax, et al, RTCPA3, Recl.Trav.Chim.Pays-Bas, 91 (1972)452 ,457
198. Ahmed, et al, JCTDAF, J.Chem.Thermodynamics, 9 (1977)1087,1090, 1091
199. Dixon, Hewitt, JCTDAF, J.Chem.Thermodynamics, 10(1978)501, 502, 503
200. Hamann, et al, AJCHAS, Aust.J.Chem., 8(1955)149,152
201. Bellm, et al, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 78(1974)282,283,285
202. Murphy, Doane, MOCRAL, Mol.Cryst., 13(1971)93
203. Kessler, et al, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 73(1969)368,369-372, 375
204. Lappert, et al, JCCCAT, J.Chem.Soc.Chem.Commun., (1975)830
205. Blake, Wade, JPCHAX, J.Phys.Chem., 75(1971)1887,1888
206. Laudo, Slutsky, JCPSA6, J.Chem.Phys., 52(1970)1510
207. Homer, et al, JCSIAP, J.Chem.Soc.A, (1970)931,934
208. Homer, et al, JCSIAP, J.Chem.Soc.A, (1970)1111,1113
209. Sauer, Hadsell, JACSAT, J.Amer.Chem.Soc., 70(1948)3593
210. Russell, JACSAT, J.Amer.Chem.Soc., 80(1958)4997,4998
211. Dewhurst, JPCHAX, J.Phys.Chem., 63(1959)1976
212. Long, JCSOA9, J.Chem.Soc., (1956) 3410,3411
213. Fritz, Raabe, ZNTFA2, Z.Naturforsch., 11b(1956)58
214. Fritz, Raabe, ZAACAB, Z.Anorg.Allg.Chem., 286(1956)149, ZAACAB, Z.Anorg.Allg.Chem., 299(1959)232
215. Miyazaki, et al, BCSJA8, Bull.Chem.Soc.Jpn., 51(1978)1679
216. Bell, Platt, JPCHAX, J.Phys.Chem., 75(1971)603
217. Majer, Al-Saigh, JFLCAR, J.Fluorine Chem., 10(1977)565,574, 57 5
218. Contineanu, et al, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 75(1971)426,430
219. O'Brien, Harbordt, JORCAI, J.Organomet.Chem., 21(1970) 321, 327
220. James, et al, CHPLBC, Chem.Phys.Lett., 68(1979)131,133
221. Austin, Lampe, JPCHAX, J.Phys.Chem., 81(1977)1134,1136
222. Taylor, Milazzo, JPCHAX, J.Phys.Chem., 82(1978)847
223. Doncaster, Walsh, JCFTAR, J.Chem.Soc.Faraday Trans.1, 72(1976)2901
224. Bell, Zucker, JPCHAX, J.Phys.Chem., 74(1970)979
225. Bell, Zucker, CJCHAG, Can.J.Chem., 48(1970)1209,1211
226. Sakurai, et al, BCSJA8, Bull.Chem.Soc.Jpn., 44(1971)568
227. Gammie, et al, JPCHAX, J.Phys.Chem., 83(1979)3075
228. Tokach, Koob, JPCHAX, J.Phys.Chem., 83(1979)774
229. Kolln, et al, CHPLBC, Chem.Phys.Lett., 65(1979)85
230. Dewhurst, Cooper, JACSAT, J.Amer.Chem.Soc., 82(1960)4220,4222
231. Fritz, Wick, ZAACAB, Z.Anorg.Allg.Chem., 342(1966)130
232. Schmidt, Allen, JCPSA6, J.Chem.Phys., 52(1970)2345,2348
233. Bell, Davidson, JORCAI, J.Organomet.Chem.,162(1978)347,352

234. Morris, Thynne, TFSOA4, Trans.Faraday Soc., 66(1970)183,184
235. Bell, et al, CJCHAG, Can.J.Chem., 52(1974)1662,1665, 1666
236. Berkley, et al, JPCHAX, J.Phys.Chem., 77(1973)1734
237. Fischer, ZPCLAH, Z.Phys.Chem.(Leipzig), 252(1973)213
238. Morris, Thynne, JORCAI, J.Organomet.Chem., 17(1969)P3,P4
239. Nay, et al, JACSAT, J.Amer.Chem.Soc., 87(1965)179
240. Lukin, Yakovlev, HIECAP, High Energy Chem.(Engl.Transl.), 12(1978)1 05
241. Davidson, JORCAI, J.Organomet.Chem., 170(1979)365,371
242. Kimura, et al, JCPSA6, J.Chem.Phys., 68(1978)3945
243. Trenerry, et al, JCPKBH, J.Chem.Soc.Perkin Trans.2, (1979) 1640
244. Mc Lean, et al, CCOMA8, Chem.Commun., (1970)452
245. Blair, et al, AJCHAS, Aust.J.Chem., 32(1979)59,60-63
246. Akhrem, et al, BACCAT, Bull.Acad.Sci.USSR Div.Chem.Sci.(Engl.Transl.), 27(1978)976,977, 979, 981
247. Roberts, Ross, JCFTAR, J.Chem.Soc.Faraday Trans.1, 68 (1972) 221, 227
248. Mains, Dedinas, JPCHAX, J.Phys.Chem., 74(1970)3476
249. Hase, Simons, JCPSA6, J.Chem.Phys., 54(1971)1277,1280
250. Harvey, et al, ORMSBG, Org.Mass Spectrom., 5(1971)599,600
251. Mains, Dedinas, JPCHAX, J.Phys.Chem., 74(1970)3483
252. Nagai, et al, TETRAB, Tetrahedron, 26(1970)2791,2793
253. Mansuy, Bartoli, JORCAI, J.Organomet.Chem., 71(1974)C32
254. Roberts, Ross, CCOMA8, Chem.Commun., (1970)1170
255. Beck, Benkeser, JORCAI, J.Organomet.Chem., 21(1970)P35
256. Franklin, MCLCA5, Mol.Cryst.Liq.Cryst., 14(1971)227,233,234
257. Daniel, Tang, JPCHAX, J.Phys.Chem., 73(1969)4378
258. Rowland, et al, JPCHAX, J.Phys.Chem., 73(1969)4024
259. Murphy, Beauchamp, JACSAT, J.Amer.Chem.Soc., 99(1977)2085,2086
260. Distefano, INOCAJ, Inorg.Chem., 9(1970)1919
261. Bell, Platt, CCOMA8, Chem.Commun., (1970)325
262. Kerr, et al, JCSIAP, J.Chem.Soc.A, (1967)134
263. Kerr, Timlin, IJCKBO, Int.J.Chem.Kinet., 3(1971)69,77
264. MacDonald, et al, AJCHAS, Aust.J.Chem., 19(1966)1527
265. Goodloe, et al, JACSAT, J.Amer.Chem.Soc., 101 (1979)3472,3474
266. Clifford, et al, JORCAI, J.Organomet.Chem., 34(1972)53,57
267. Baldwin, et al, TFSOA4, Trans.Faraday Soc., 64(1968)2708
268. Fritz, Grobe, ZAACAB, Z.Anorg.Allg.Chem., 315(1962)157
269. Shiino, Kumada, Mem.Fac.Sci.Eng.Osaka Univ., 2(1960)128,129-1 34, CA (1961)25732
270. Reavill, JCSOA9, J.Chem.Soc., (1964)519
271. Miles, et al, PRLAAZ, Proc.R.Soc.London A, 291(1966)167
272. Golesworthy, Shaw, PRLAAZ, Proc.R.Soc.London A, 292(1966)489,497
273. Bridger, Russel, JACSAT, J.Amer.Chem.Soc., 85(1963)3754,3763
274. Bridger, Russel, JACSAT, J.Amer.Chem.Soc., 85(1963)3754
275. Calas, et al, CHDCAQ, C.R.Hebd.Seances Acad.Sci.Ser.C, 263 (1966)243
276. Cheng, Szwarc, JPCHAX, J.Phys.Chem., 72(1968)494
277. Rothe, Helbing, JCPSA6, J.Chem.Phys., 53(1970)1555
278. Birot, et al, BSCFAS, Bull.Soc.Chim.Fr., (1978)1-442
279. Johnson, et al, JCPSA6, J.Chem.Phys., 52(1970)3911
280. Mansuy, et al, JORCAI, J.Organomet.Chem., 77(1974)C49
281. Price, Sowa, JOCEAH, J.Org.Chem., 32(1967)4126

282. Yates, et al, JPCHAX, J.Phys.Chem., 73(1969)911
283. Snediker, Miller, RAACAP, Radiochim. Acta, 10(1968)30
284. Baldwin, et al, JCFTAR, J.Chem.Soc.Faraday Trans.1, 74(1978)2171,21 72,21 73
285. Byakov, et al, HIECAP, High Energy Chem.(Engl.Transl.), 12(1978)346,350
286. Fomichev, et al, JSTCA~l, J.Struct.Chem.(Engl.Transl.), 11 (1970)626 ,627
287. Parkhurst, Jonas, JCPSA6, J.Chem.Phys., 63(1975)2705
288. Holroyd, Allen, JCPSA6, J.Chem.Phys., 54(1971)5014,5020
289. O'Neil, Ring, INOCAJ, Inorg.Chem., 5(1966)435,436-438
290. Mosin, RJPCAR, Russ.J.Phys.Chem. (Engl.Transl.), 46(1972)318
291. Bacon, et al, JACSAT, J.Amer.Chem.Soc., 93(1971)2537
292. Price, JOCEAH, J.Org.Chem., 38(1973)615
293. Burton, et al, CJCHAG, Can.J.Chem., 49(1971)588
294. Bacon, Maciel, JACSAT, J.Amer.Chem.Soc., 95(1973)2413,2416, 241 8
295. Koeberg-Telder, Cerfontain, JCPKBH, J.Chem.Soc.Perkin Trans.2, (1975)226
296. Hobson, Kaiser, JOMRA4, J.Magn.Reson., 20(1975)458
297. Schweighardt, et al, ANCHAM, Anal.Chem., 50(1978)368,370
298. Krueger, Spieseche, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 75(1971)272
299. Linde, et al, JACSAT, J.Amer.Chem.Soc., 97(1975)3219
300. Wrackmeyer, Biffar, ZNBAD2, Z.Naturforsch.B Anorg.Chem.Org.Chem., 34(1979)1270,1271
301. Burg, INUCAF, Inorg.Nucl.Chem.Lett., 13(1977)199,201
302. Rakita, Worsham, INUCAF, Inorg.Nucl.Chem.Lett., 13(1977)547
303. Scholl, et al, JACSAT, J.Amer.Chem.Soc., 94(1972)6376
304. Dutton, Onyszchuk, INOCAJ, Inorg.Chem., 7(1968)1735,1739
305. Levy, JACSAT, J.Amer.Chem.Soc., 94(1972)4793
306. Inamoto, Masuda, TELEAY, Tetrahedron Lett., (1977)3287
307. Wolff, Radeglia, ORMRBD, Org.Magn.Reson., 9(1977)64
308. Ostdick, McCusker, INOCAJ, Inorg.Chem., 6(1967)98
309. Albert, Ripmeester, JCPSA6, J.Chem.Phys., 57(1972)2641
310. Berche, Kelen, JORCAI, J.Organomet.Chem., 59(1973)175,177,1 79,1 85
311. Schraml, et al, CCCCAK, Collect.Czech.Chem.Commun., 44(1979)854,856
312. Raynes, Raza, MOPHAM, Mol.Phys., 17(1969)157,160,163
313. Ariyaratne, et al, JCSIAP, J.Chem.Soc.A, (1969)1309,1318
314. Barcza, Engstrom, JACSAT, J.Amer.Chem.Soc., 94(1972)1762
315. Lukewiz, et al, KELSDE, Khim.Elementoorg.Soedin., (1976)63, CA85(1976)192836b
316. Mitchell, El-Behairy, JORCAI, J.Organomet.Chem., 172(1979)293,296
317. Loewer, et al, CMKZAT, Chem.Ztg., 99(1975)33
318. Marsmann, Horn, CMKZAT, Chem.Ztg., 96(1972)456
319. Tuchagues, et al, SIMOAI, Synth.Inorg.Met.Org.Chem., 5(1975)279,286
320. Bothner-By, JMOSA3, J.Mol.Spectrosc., 5(1960)52
321. Radeglia, Gey, JPCEAO, J.Prakt.Chem., 313(1971)1070
322. Dreeskamp, Stegmeier, Z.Naturforsch.A, 22(1967)1458
323. Kawazoe, Ohnishi, CPBTAL, Chem.Pharm.Bull., 11 (1963)243,246
324. Spiesecke, Schneider, JCPSA6, J.Chem.Phys., 35(1961)722,723, 725
325. Van Dyke Tiers, JPCHAX, J.Phys.Chem., 64(1960)373
326. Schmidbaur, Schmidt, JACSAT, J.Amer.Chem.Soc., 84 (1962)1069
327. van den Berghe, van der Kelen, JORCAI, J.Organomet.Chem., 1 22(1976)329
328. Smith, JCPSA6, J.Chem.Phys., 40(1964)2037

329. Friedrich, ZENBAX, Z.Naturforsch.B Anorg.Chem.Org.Chem.Biochem.Biophys.Biol., 20(1965)1021
330. Vakhrin, RJPCAR, Russ.J.Phys.Chem. (Engl.Transl.), 50(1976)1 81 9
331. Snyder, Meiboom, JCPSA6, J.Chem.Phys., 44(1966)4057
332. McLean, Sacher, JORCAI, J.Organomet.Chem., 74(1974)197,200
333. Schmidbaur, et al, ZAACAB, Z.Anorg.Allg.Chem., 328(1964)105, 110
334. Raza, Raynes, MOPHAM, Mol.Phys., 19(1970)199,206
335. Brown, Webster, JPCHAX, J.Phys.Chem., 64(1960)698
336. Montana, Dailey, JOMRA4, J.Magn.Reson., 22(1976)117
337. Becconsall, MOPHAM, Mol.Phys., 18(1970)337,340
338. Hesse, et al, JCPSA6, J.Chem.Phys., 57(1972)749
339. Chkheidze, et al, KICAA8, Kinet.Catal.(Engl.Transl.), 7(1966)208
340. Roncin, MOCRAL, Mol.Cryst., 3(1967)117,134
341. Mizushima, Adv.Mol.Spectr.Proc.4th.Int.Meet., 1(1962)60
342. McKean, SAMCAS, Spectrochim.Acta Part A, 29 (1973)1559, 1563
343. Brown, et al, JMOSB4, J.Mol.Struct., 40(1977)43,53, 54
344. Egorov, et al, JASYAP, J.Appl.Spectrosc.(Engl.Transl.), 2 (1965)104
345. Tertykh, et al, TEXCAK, Theor.Exp.Chem.(Engl.Transl.), 11(1975)136,138
346. Newman, et al, JORCAI, J.Organomet.Chem., 137(1977)281, 282
347. Kriegsmann, et al., ZPCLAH, Z.Phys.Chem.(Leipzig), 240 (1969)294
348. Smith, SPACA5, Spectrochim.Acta, 16(1960)87,89
349. Graham, SAMCAS, Spectrochim.Acta Part A, 26(1970)345, 361, 362
350. Durgar'jan, et al, JGCHA4, J.Gen.Chem.USSR (Engl.Transl.), 30(1960)2583, ZOKHA4, Zh.Obshch.Khim., 30(1960)2600
351. Sunder, McClung, CJPHAD, Can.J.Phys., 54(1976)211
352. Shevchenko, et al, SPHDA9, Sov.Phys.Dokl.(Engl.Transl.), 14(1969)137, DANKAS, Dokl.Akad.Nauk SSSR, 184(1969)824
353. Harada, et al, CHPLBC, Chem.Phys.Lett., 1(1968)595
354. Alexander, et al, CHPLBC, Chem.Phys.Lett., 13(1972)608
355. Schmidt, Schnabel, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 75(1971)654,657
356. Abraham, Johnston, JCSIAP, J.Chem.Soc.A, (1971)1610,1611
357. Anderson, Sleddon, CHINAG, Chem.Ind.(London), (1960)1335
358. Morris, Thynne, JPCHAX, J.Phys.Chem., 73(1969)3294
359. Becconsall, Hampson, MOPHAM, Mol.Phys., 10(1966)21,31
360. Baumgaertner, et al, ZAACAB, Z.Anorg.Allg.Chem., 333(1964) 171 ,174
361. Stolberg, Fritz, ZAACAB, Z.Anorg.Allg.Chem., 330(1964)1,3
362. Rummens, et al, JPCHAX, J.Phys.Chem., 72(1968)2111
363. Hess, et al, JACSAT, J.Amer.Chem.Soc., 87(1965)5327,5329
364. Rotzsche, ZAACAB, Z.Anorg.Allg.Chem., 328(1964)79,82
365. Kessler, et al, BBPCAX, Ber.Bunsen-Ges.Phys.Chem., 71 (1967)3
366. Spangenberg, Pfeiffer, ZPCLAH, Z.Phys.Chem.(Leipzig), 232(1966)343
367. Anisimov, et al, CMPHC2, Chem.Phys., 44(1979)367
368. Sowada, et al, HIECAP, High Energy Chem.(Engl.Transl.), 10(1976)290
369. Ratcliffe, Waddington, JCFTBS, J.Chem.Soc.Faraday Trans.2, 72(1976)1 840,1 847
370. Bundel, et. al, BACCAT, Bull.Acad.Sci.USSR Div.Chem.Sci.(Engl.Transl.), 28 (1979)1959
371. Atake, Chihara, CHPLBC, Chem.Phys.Lett., 56(1978)330
372. Sano, Mozumder, JCPSA6, J.Chem.Phys., 66(1977)689,693
373. Amdur, et al, JCPSA6, J.Chem.Phys., 64(1976)3602

374. Kihara, et al, CHPLBC, Chem.Phys.Lett., 9(1971)62
375. Cipollini, Allen, JCPSA6, J.Chem.Phys., 67(1977)131
376. Burberry, Albrecht, JCPSA6, J.Chem.Phys., 71(1979)4631
377. Mehta, Zeldin, ICHAA3, Inorg.Chim.Acta, 22(1977)L33
378. Domain, et al, CJCHAG, Can.J.Chem., 54(1976)2101
379. Doeldissen, Schmidt, CHPLBC, Chem.Phys.Lett., 68(1979)527
380. Lichtenthaler, et al, CJCHAG, Can.J.Chem., 51(1973)3071, 3074
381. De Ligny, et al, RTCPA3, Recl.Trav.Chim.Pays-Bas, 90(1971) 1265
382. Holroyd, Cipollini, JCPSA6, J.Chem.Phys., 69(1978)501
383. Krause, Potzinger, IJMIBY, Int.J.Mass Spectrom.lon Phys., 18(1975)303
384. Heumann, et al, ZNBAD2, Z.Naturforsch.B Anorg.Chem.Org.Chem., 28(1973)107, 11 0
385. Nagy, Reffy, JORCAI, J.Organomet.Chem., 22(1970)565,570,571
386. Sportouch, et al, JMOSB4, J.Mol.Struct., 9(1971)119,122
387. Rastelli, Pozzoli, JMOSB4, J.Mol.Struct., 18(1973)463,466
388. Gribov, OPSUA3, Opt.Spectros.(Engl.Transl.), 11(1961)77
389. Gutowsky, Tai, JCPSA6, J.Chem.Phys., 39(1963)208,210
390. Nagy, et al, ACASA2, Acta Chim.Acad.Sci.Hung., 65(1970)51, 54
391. Chang, Berry, JCPSA6, J.Chem.Phys., 61(1974)2727,2731
392. Dorsch, De Rocco, JCPSA6, J.Chem.Phys., 54(1971)2727
393. Schmidt, Allen, JCPSA6, J.Chem.Phys., 50(1969)5037
394. Krueger, Spiesecke, Z.Naturforsch.A, 28(1973)964
395. Schmidbaur, CHBEAM, Chem.Ber., 97(1964)270
396. Turkeltaub, et al, PLMSAI, Plast.Massy, 4(1961)51,52-56, CA (1962)2003
397. Schmidbaur, et al, CHBEAM, Chem.Ber., 97(1964)255
398. Vele, et al, CCCCAK, Collect.Czech.Chem.Commun., 36(1971)4111,4113
399. Lazzeretti, Taddei, TELEAY, Tetrahedron Lett., (1969)3025
400. Sanyal, et al, SPLEBX, Spectrosc.Lett., 9(1976)697,701
401. Van Dyke Tiers, JPCHAX, J.Phys.Chem., 65(1961)1916
402. Fritz, et al, ZAACAB, Z.Anorg.Allg.Chem., 312(1961)201
403. Kiser, Gallegos, JPCHAX, J.Phys.Chem., 66(1962)947
404. Innorta, et al, ACASA2, Acta Chim.Acad.Sci.Hung., 89 (1976) 23 ,25
405. Connor, et al, CCOMA8, Chem.Commun., (1966)178
406. Davidson, Stephenson, CCOMA8, Chem.Commun., (1966)746
407. Jackson, JORCAI, J.Organomet.Chem., 166(1979)17
408. Deacon, Jones, AJCHAS, Aust.J.Chem., 15(1962)555,556
409. Frei, Bernstein, JCPSA6, J.Chem.Phys., 37(1962)1891
410. Dorfman, Lependina, JSTCAM, J.Struct.Chem.(Engl.Transl.), 5(1964)582, ZSTKAI, Zh.Strukt.Khim., 5(1964)632
411. Hunter, Reeves, CJCHAG, Can.J.Chem., 46(1968)1399,1404
412. Sundermeyer, Verbeek, ANCEAD, Angew.Chem., 78(1966)107,111
413. Tominaga, et al, JPCHAX, J.Phys.Chem., 73(1969)465
414. Van der Kelen, et al, ZAACAB, Z.Anorg.Allg.Chem., 338(1965)106, 108
415. Kostjanowskii, BACCAT, Bull.Acad.Sci.USSR Div.Chem.Sci.(Engl.Transl.), (1967)2659
416. Witkin, Wolfgang, JPCHAX, J.Phys.Chem., 72(1968)2631
417. Freeman, JCPSA6, J.Chem.Phys., 65(1976)5536
418. Dotoku, et al, JCPSA6, J.Chem.Phys., 69(1978)1121
419. Chang, Setser, JCPSA6, J.Chem.Phys., 58(1973)2298

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$136.34 Estimated total session cost 0.140 Hrs. Logoff: level 25.02.15 A 12:51:32

DIALNET: call cleared by request

Enter Service: