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# A Report on the Twenty-fifth Symposium on Heteroatom Chemistry of the Chemical Society of Japan

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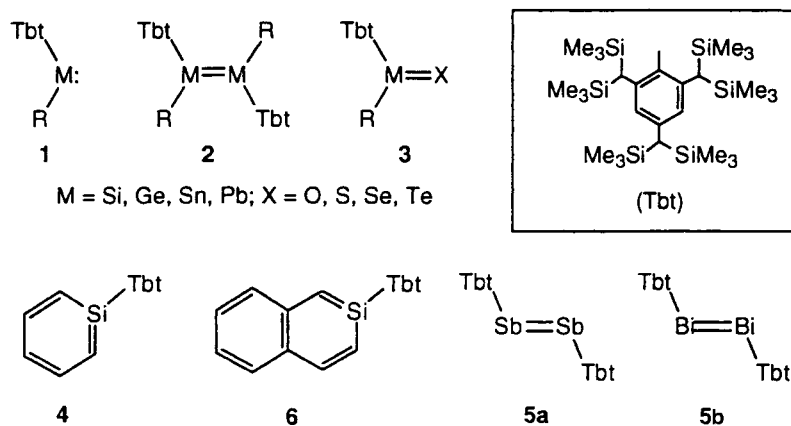
The 25th domestic Chemical Society of Japan Symposium of Heteroatom Chemistry was held in Kyoto during the period of December 9–11, 1998, under the management of Professor Hitomi Suzuki of Kyoto University. We had four plenary lectures, namely, by Prof. Norihiro Tokitoh of Kyusyu University, Prof. Mituo Kira of Tohoku University, Prof. Jozef Drabowicz of Polish Academy of Sciences, and Prof. Peter J. Stang of University of Utah. This article summarizes the four plenary lectures and 53 oral communications and provides the titles of 50 posters presented at the meeting that included 262 participants.

The first plenary lecture was presented by Prof. N. Tokitoh on "New Aspects in the Chemistry of Heteroatom-Containing Multiple Bonds." The first part of the lecture covered his area of interest about the age-old subject of the synthesis of tremendously crowded compounds, low-coordinate organoheteroatom compounds, such as divalent species of heavier group 14 elements **1**; doubly bonded species of heavier group 14 elements **2**; and a series of group 14 and 16 double-bonded compounds **3**. He also showed the synthesis of the first examples of stable sila-aromatics, silabenzene **4** and silanaphthalene **6**, and the first isolation of a stable distibene **5a** and

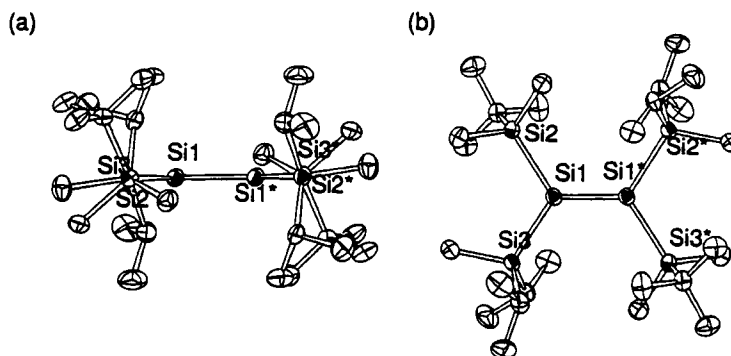
dibismuthene **5b** (Scheme 1). It should be mentioned that the numbering of compounds in this scheme is applicable only to this scheme and not to that of the other schemes, each of which has its own numbering system.

The second plenary lecture by Prof. M. Kira concerned successful isolation and properties of various compounds containing Si=Si double bonds, subject being "Cyclic and Acyclic Disilenes Stabilized by Bulky Trialkylsilyl Substituents." While presenting single-crystal X-ray diffraction data, as shown in Scheme 2, and UV-vis spectra, he mentioned unique effects of trialkylsilyl substituents on disilenes that have been revealed by structural characteristics such as long Si=Si bond distances, remarkable dependence of the electronic spectra on the alkyl-substituents on silicon, very low field <sup>29</sup>Si NMR resonances of the unsaturated silicon nuclei, and very low activation free energies for *E,Z*-isomerization of disilenes. The cyclotetrasilene and the cyclotrisilene **7** having a Si=Si bond were synthesized as shown in Scheme 3.

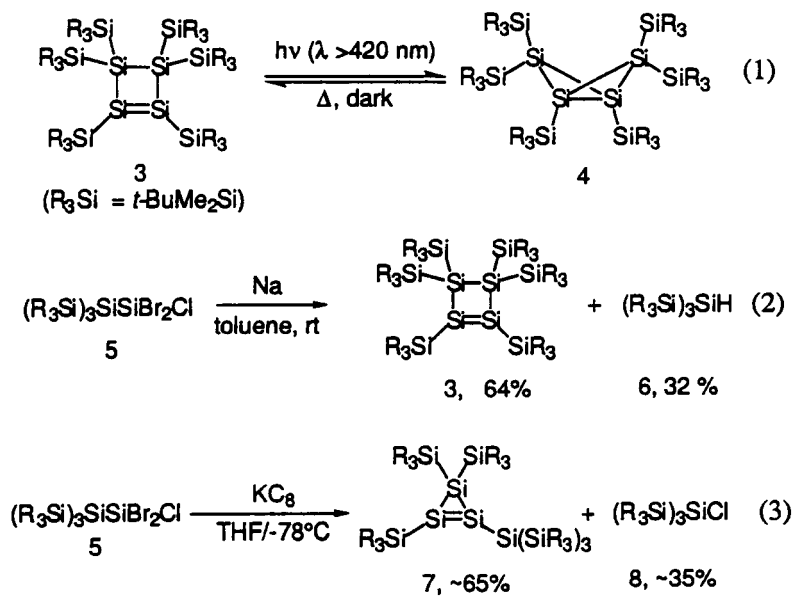
The third plenary lecture by Prof. J. Drabowicz was entitled "Can Selected Optically Active Sulfuranes Be Used as a Probe for the Stereochemical Course of Nucleophilic Substitution at a Chiral Sulfinyl Sulfur Atom?" He presented Scheme 4 to illustrate the change of the stereochemical course of substitution reactions on the sulfur atom as a function of the topological properties of trigonal bipyramidal



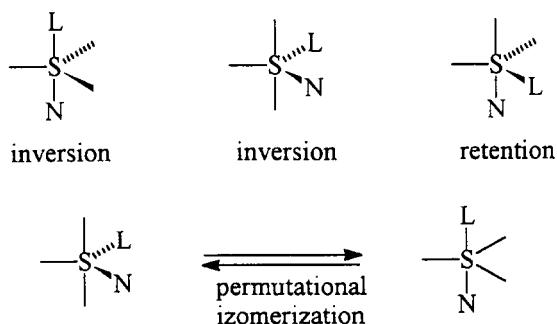
SCHEME 1



SCHEME 2



SCHEME 3



SCHEME 4

geometry (TBP). The actual reactions are shown in Scheme 5. He extended his lecture to depict the synthesis of optically active spiro-sulfuranes by use of Martin's ligands (Scheme 6).

The final plenary lecture was given by Prof. P. J. Stang on "Molecular Architecture: Design and Self-Assembly of Metallacyclic Polygons and Polyhedra via Coordination." He described the general design principles, along with self-assembly and characterization of diverse metallacyclic molecular squares, pentagons, and hexagons as shown in Scheme 7. The formation of novel three-dimensional assemblies was presented with the design principles and advantages of the coordination motif in the construction of supramolecular species.

Among the 53 regular presentations, in the following are some of the more impressive lectures.

Prof. A. Ogawa and Prof. S. Hirao on "The Highly Selective Carbon-Component Coupling by Use of a Dichalcogenide- $h\nu$  System," in which the reaction shown in Scheme 8 can be rationalized by the selective addition of a seleno radical to an alkyne, the addition of the thusly formed vinylic radical to an olefin, and the subsequent  $S_{\text{H}}2$  reaction with a diselenide.

Prof. A. Ishii and Prof. J. Nakayama made a presentation that dealt with the first synthesis and structural characterization of a novel selenoseleninate (Scheme 9).

Prof. T. Kataoka and his coworker stated that there was an apparent ligand coupling reaction *via* a selenurane intermediate, along with the formation of an aryne intermediate in the reactions of an alkynyl(diphenyl)selenonium salt with phenyllithium, as shown in Scheme 10.

Prof. T. Yoshimura gave a lecture on "Synthesis and Reactivities of *S*-Aminothiazynes." He described a probable mechanism of the thermolysis of an *S*-

Aminothiazynes as suggested by the results of kinetics experiments (Scheme 11).

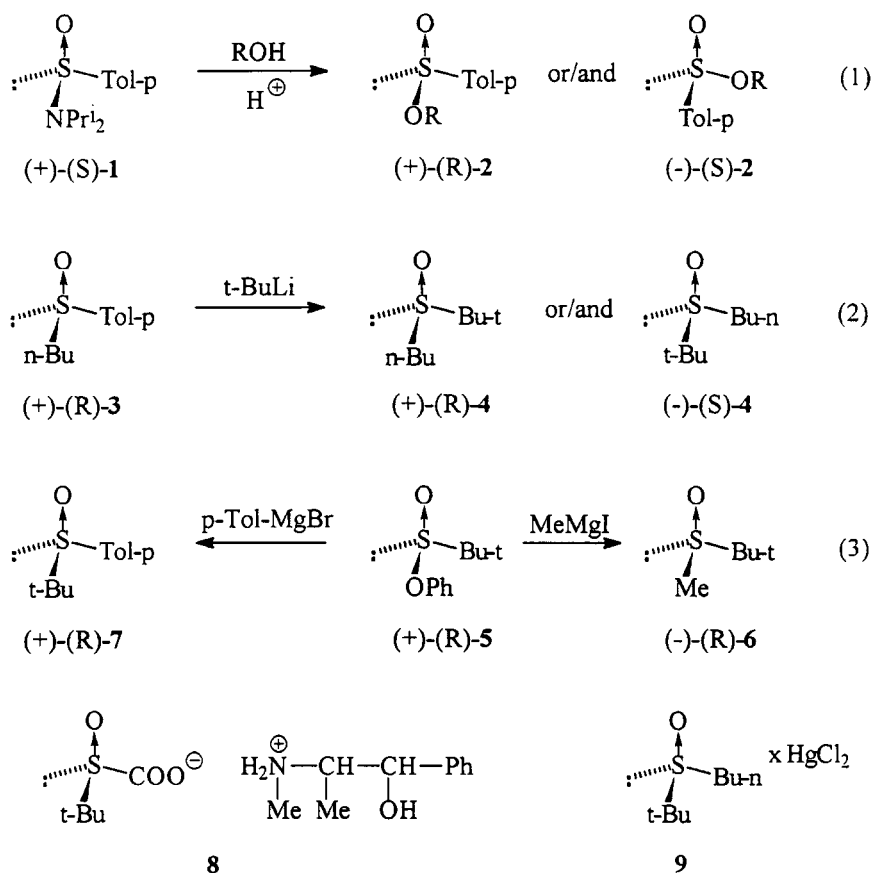
Prof. A. Sekiguchi's article was read by Dr. N. Fukaya, and the new germanium chemistry is summarized in Scheme 12. An ORTEP drawing of a novel cyclotrigermanium ion indicates that the three-membered ring of germanium atoms is almost an equilateral triangle and that the Ge-Ge distances of the three-membered ring are almost equal.

Prof. Kambe and Prof. N. Sonoda had requested Dr. J. Terao to read an article on "New Silylation Reactions of Olefins Using a Titanocene Catalyst." The authors mentioned that the following transition metal catalyzed silylations easily took place (Scheme 13).

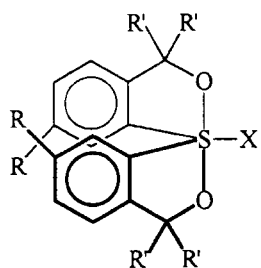
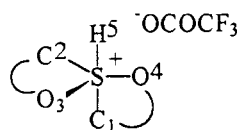
Among 50 poster presentations, only one is selected for presentation here: "Synthesis and Reactions of Bismuthane Imides." Prof. H. Suzuki had asked his student, H. Nomura, to read their article. They mentioned that the *o*-tolyl and *o*-anisyl group could stabilize the B=N double bond in *N*-acylbismuthane imides kinetically (Scheme 14).

### Oral Presentations

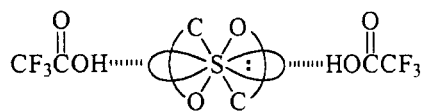
1. "Structure of Chalcogenocarboxylic Acid Group 14 Element Esters" by K. Tani, O. Niyomura, T. Kanda, and S. Kato (Gifu University).
2. "Selenium-Catalyzed Reaction of Nitroarenes with Carbon Monoxide" by R. Maema, K. Ohno, Y. Nishiyama, and N. Sonoda (Kansai University and KU-HRC).
3. "Reaction of Isonitriles with Benzeneselenenyl Fluoride Generated by the  $\text{XeF}_2\text{-(PhSe)}_2$  System" by K. Uneyama, S. Hiraoka, and H. Amii (Okayama University).
4. "Highly Selective Carbon-Component Coupling by Use of a Dichalcogenide- $h\nu$  System" by A. Ogawa, M. Doi, and T. Hirao (Osaka University).
5. "Formation of Selenoseleninates by Condensation of Selenide Acids and Their Properties" by A. Ishii, T. Takahashi, S. Matsubayashi, and J. Nakayama (Saitama University).
6. "Synthesis and Polyfunctionalized Compounds Utilizing the Reaction of 1-Alkynes Having a Phenylseleno Group with Organometallic Reagents" by I. Yokoe, M. Segi, and T. Nakajima (Kanazawa University).
7. "Excimer Laser Photolysis of Alkyl Phenyl Selenides" by A. Ouchi and Y. Koga (National Institute of Materials and Chemical Research).
8. "Reactions of Alkylselenonium Salts with Phenyllithium: The First Example of Benzynes Inter-



SCHEME 5

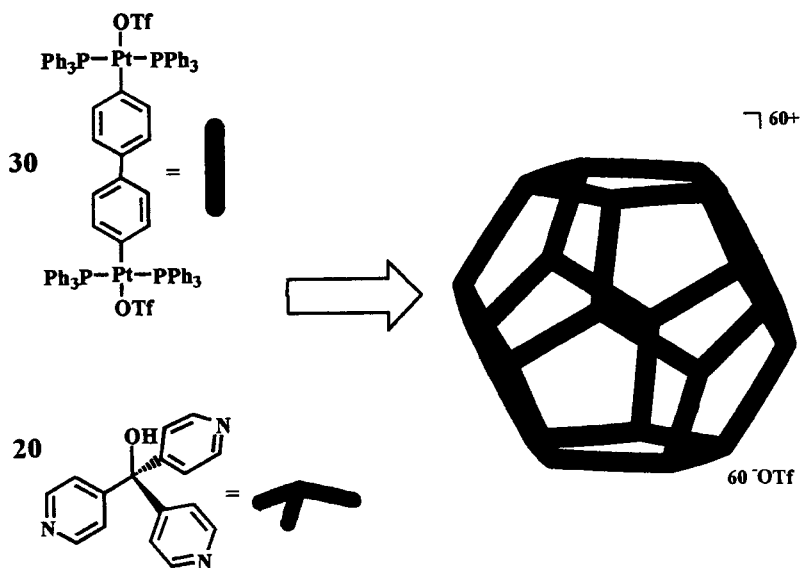
10a R=H, R<sup>1</sup>=CH<sub>3</sub>, X=:b R=H, R<sup>1</sup>=CH<sub>3</sub>, X=O11a R=t-Bu, R<sup>1</sup>=CF<sub>3</sub>, X=:b R=t-Bu, R<sup>1</sup>=CF<sub>3</sub>, X=O

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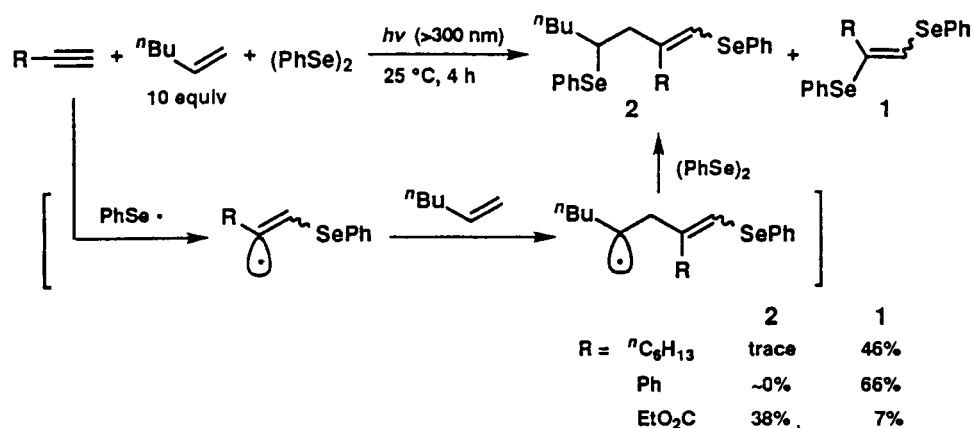


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SCHEME 6



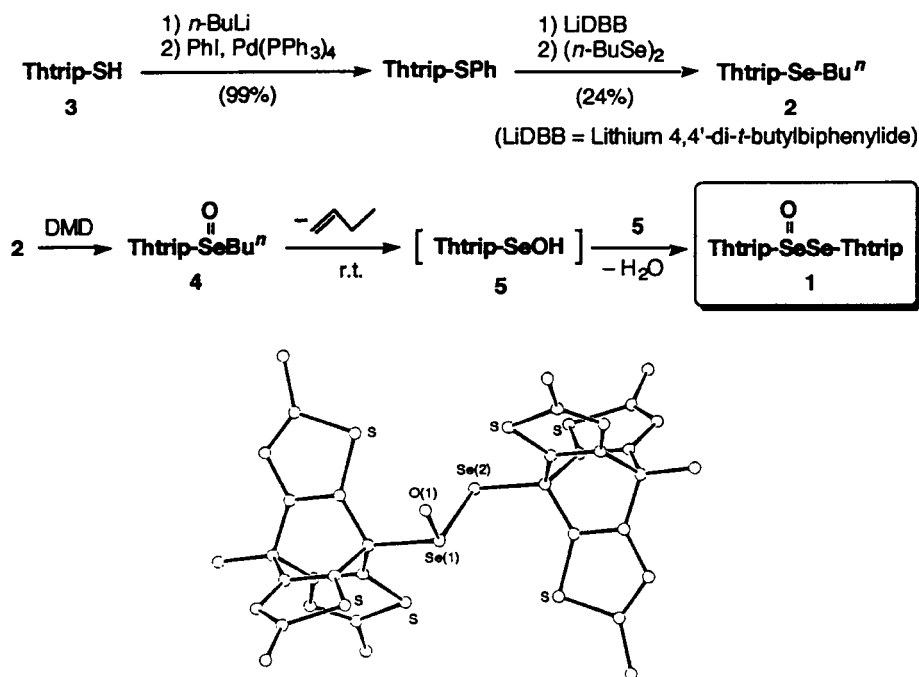
SCHEME 7



SCHEME 8

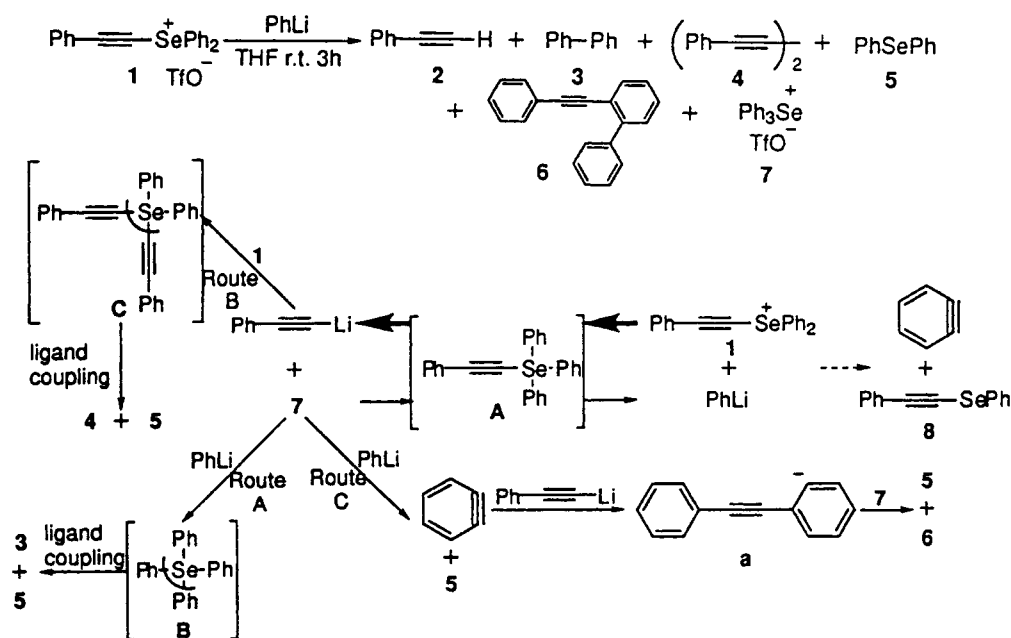
mediate Formation from Seleninium Salts” by T. Kataoka, S. Watanabe, and K. Yamamoto (Gifu Pharmaceutical University).

- “Molecular Bromine Inclusion in Selenanthrene Dibromide I: First Observation of a Molecular Complex in Selenide Dibromides, Together with the Formation of Seven Center-Ten Electron Bonds” by W. Nakanishi, S. Hayashi, S. Yamaguchi, and K. Tamao (Wakayama University and Kyoto University).
- “Debromination of *vic*-Dibromides with 1,5-Dichalcogenacyclopentane Induced by Transannular Chalcogen–Chalcogene Interaction” by Y. Takaguchi, A. Hosokawa, S. Yamada, J. Motoyoshiya, and H. Aoyama (Shinshu University).
- “Reaction of 2-Benzotelluropyrylium Salts and 2-Benzoselenopyrylium Salts with Nucleophiles” by H. Sashida and K. Ohyanagi (Hokuriku University).
- “Synthesis and Characterization of a Novel Hypervalent Tellurium Compound,  $\text{Ph}_5\text{Te}$ ” by M. Minoura, T. Mukuda, and K. Akiba (Hiroshima University).
- “Synthetic Reactions of 1-Phenyl-2-halopropenes *via* Nucleophilic Substitution of the Phenyltelluro Group in 1-Phenyl-2-phenyltelluropropane” by F. Ogura, Y. Okada, N. Nishimura, T. Otsubo, Y. Aso, S. Inoue, and K. Tsutsui (Kinki University, Hiroshima University).
- “Synthesis and Characterization of Oligotelluroxanes” by K. Kobayashi, N. Deguchi, K. Tanaka, H. Izawa, O. Takahashi, E. Horn, and N. Furukawa (University of Tsukuba).
- “Synthesis and Redox Reactions of Novel Tri-

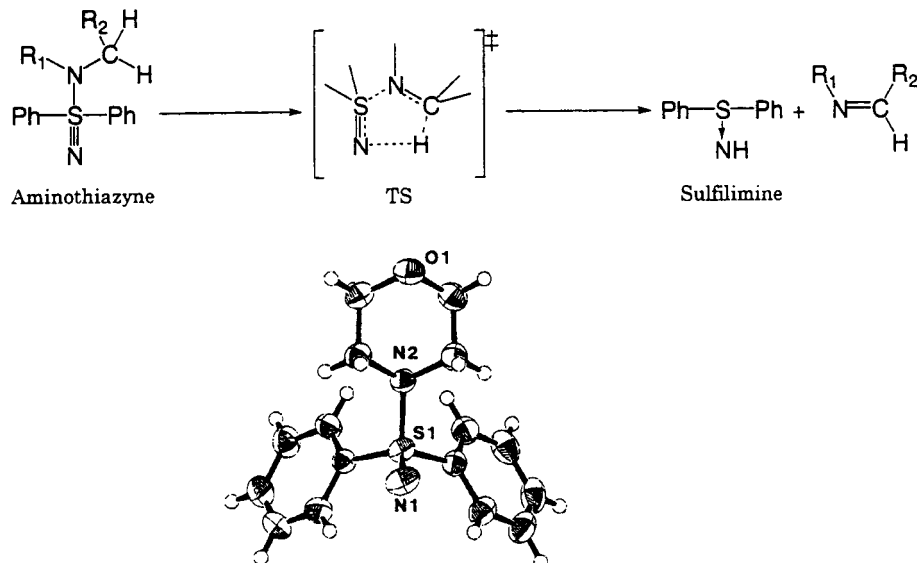


SCHEME 9

- chalcogenoles Containing a Tellurium Atom” by S. Ogawa, S. Yoshimura, Y. Kawai, T. Kimura, and R. Sato (Iwate University, Kyoto University).
16. “Synthesis, Structures, and Reactions of Tetra-coordinate 1,2-Oxatelluretanes” by T. Kawashima, T. Abe, and R. Okazaki (The University of Tokyo, Japan Women’s University).
  17. “The Effect of a Cobalt(II) Complex on the Reactivity of a Radical Reaction of Sulfur-Containing Functions” by M. Tada, T. Uetake, K. Kaneko, and Y. Hanaoka (Waseda University).
  18. “Free Radical Substitution in Metalladithiolene Rings” by A. Sugimori, M. Kajitani, K. Suzuki, K. Maeshima, and K. Hattori (Sophia University).
  19. “A Novel Method for the Preparation of Lithiomethyl Allylic Ethers and Its [2,3]-Wittig Rearrangement” by T. Ishikawa, K. Miki, and S. Saito (Okayama University).
  20. “Stereoselective Conjugate Addition of a  $\beta$ -Silyl-ethyl Sulfoxide” by S. Nakamura, Y. Watanabe, and T. Toru (Nagoya Institute of Technology).
  21. “Reactions of Silylketenes with Nitrones” by K. Kataoka, T. Aoyama, and T. Shioiri (Nagoya City University).
  22. “Stereoselective Michael/Aldol Tandem Reaction Triggered by a Thiolate Anion” by A. Kamimura, H. Mitsueda, Y. Omata, and A. Kakehi (Yamaguchi University, Shinshu University).
  23. “Synthesis and Asymmetric Pummerer Reaction of Chiral Sulfoxides Having Potential for Non-bonded S . . . O Interactions” by Y. Nagao, S. Miyamoto, K. Hayashi, A. Mihara, and S. Sano (The University of Tokushima).
  24. “Formation of Thiocarbonyl Compounds from Sulfoxide Derivatives Bearing Heteroaromatics” by M. Takada, T. Fujii, S. Ono, T. Yoshimura, C. Shimazaki, and H. Morita (Toyama University).
  25. “Asymmetric Synthesis and Diastereoselective Hydrolysis of Optically Pure Spirosulfuranes” by J. Zhang, S. Saito, T. Koizumi, and S. Tomoda (Toyama Medical and Pharmaceutical University, The University of Tokyo).
  26. “Asymmetric Reduction of  $\alpha,\beta$ -Unsaturated Ketones Utilizing Thiols: Mechanism and New Development of the Tandem Michael–MPV Reaction” by K. Nishide, H. Shiraki, Y. Shigeta, K. Obata, and M. Node (Kyoto Pharmaceutical University).
  27. “Knoevenagel Reaction of Benzothiazolylsulfonylacetates: Reactivity and Synthetic Application” by S. Sumida, J. Mitani, Y. Kasahara, T. Miyagawa, and J. Nokami (Okayama University of Science).
  28. “Synthetic Use of 1-(Arenesulfonyloxy)-1,2-benziodoxol-3(1*H*)-ones” by T. Muraki, H. Togo, and M. Yokoyama (Chiba University).
  29. “Synthesis of Oxabicyclo[3.3.0]octane Deriva-



SCHEME 10



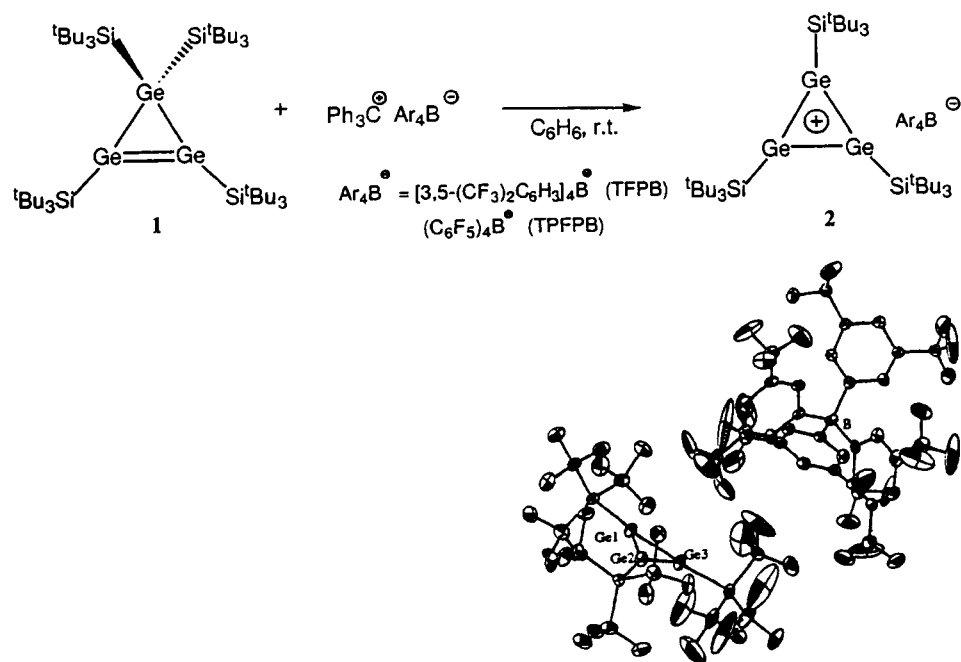
SCHEME 11

tives through Fe(III) Mediated Oxidative Cyclization Reaction of Cyclopropanone Dithioacetal” by H. Ohara, T. Itoh, M. Nakamura, and E. Nakamura (Okayama University, The University of Tokyo).

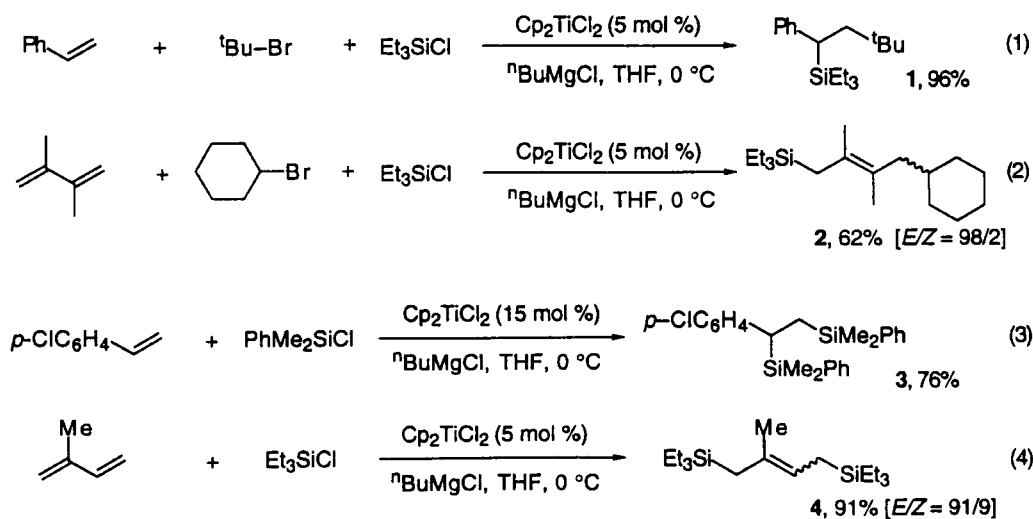
30. “Synthesis and Properties of TTF Oligomers” by K. Hara, Y. Kuwatani, and M. Iyoda (Tokyo Metropolitan University).
31. “Synthesis and Properties of a Liquid Crystalline

Hexa-Substituted Benzene with Oligothiophene Units” by S. Inoue, S. Murakami, S. Nishiguchi, Y. Aso, T. Otsubo, V. Vill, and A. Mori (Hiroshima University, Kyusyu University).

32. “Diastereoselective Conversion of Organic Sulfides into Sulfilimides by 1,6-Asymmetric Induction” by H. Takada, K. Ohe, and S. Uemura (Kyoto University).
33. “The Diels-Alder Reaction of 1-Phenyl-1-benzo-



SCHEME 12



SCHEME 13

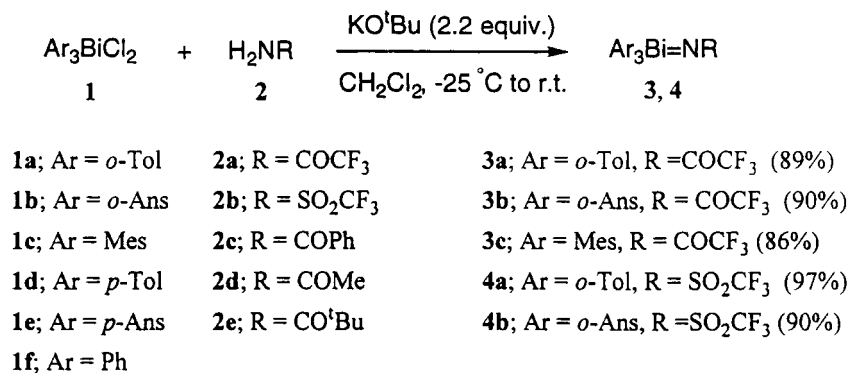
thiophenium Salts with Dienes” by T. Kitamura, B. Zhang, and Y. Fujiwara (Kyusyu University).

34. “Polar Cycloadditions of Cyclic Conjugated Compounds Containing a Sulfur–Nitrogen Double Bond” by H. Shimizu, T. Hatano, T. Matsuda, and T. Iwamura (Gifu Pharmaceutical University).
35. “Synthesis and Reactivities of *S*-Aminothiazynes” by T. Yoshimura, S. Murotani, I. Tada, S. Hanawa, T. Miyake, T. Fujii, S. Ono, H. Morita, and

E. Horn (Toyama University, University of Tsukuba).

36. “Formation and Heteroatom Effect of Self-Assembled Monolayers by Multi-Adsorption and Multilayers” by H. Nakai, M. Yoshihara, T. Maeshima, and H. Fujihara (Kinki University).
37. “Facile Generation of Diatomic Sulfur by Using Phase-Transfer Catalysts and Reaction with Olefins” by Y. Koga, S. Kuge, K. Shioji, H. Wakita, and K. Okuma (Fukuoka University).





## SCHEME 14

38. "New Synthesis of Di and Polysulfides under Dry Conditions" by T. Takata, M. Nishi, and N. Yamada (Osaka Prefecture University, DAISO Co., LTD.).
39. "Ring Conversion Reaction of Cyclic Polyenes Possessing Disulfide Bonds" by T. Shimizu, H. Murakami, Y. Kobayashi, and N. Kamigata (Tokyo Metropolitan University).
40. "Control of the Reactivity of Divalent Silicon Species by the Intramolecular Coordination of 8-Dimethylamino-1-naphthyl Group -Nucleophilic Silylene or Silylenoid-" by A. Toshimitsu, M. Asahara, T. Saeki, and K. Tamao (Kyoto University).
41. "Synthesis and Reaction of Cyclotrigermenium Ions" by N. Fukaya, M. Ichinohe, and A. Sekiguchi (University of Tsukuba).
42. "Reactions of Aromatic Compounds with a Phenylnitrenium Ion Intermediate Generated from *N*-Phenylhydroxylamine" by H. Takeuchi, T. Taniguchi, and M. Kawamura (Kobe University).
43. "One-Pot Synthesis of Polycyclic Azaarenes by the Cycloaddition of Nitropyridine with Ethyl Isocynoacetate" by T. Murashima, K. Nishi, N. Ono, and H. Suzuki (Ehime University, Kyoto University).
44. "Construction of  $\pi$ -Conjugated Systems Possessing Phosphorus Functional Groups by Reaction of Acetylenes with Transition Metal Complexes" by Y. Tanabe, S. Sasaki, and M. Yoshifuji (Tohoku University).
45. "Syntheses, Structures, and Reactions of 1,3,2,4-Dichalcogenametalloboretanes, Boron-Containing Four-Membered Ring Compounds Bearing a Bulky Substituent" by M. Ito, N. Tokitoh, and R. Okazaki (The University of Tokyo, Japan Women's University).
46. "Synthesis and Reactions of *B*-Functionalized Phosphine Boranes" by H. Ohtsuka, H. Morishita, and T. Imamoto (Chiba University).
47. "Synthesis and Structure of Novel Nucleoside Derivatives of Phospha Sugar Analogs" by M. Yamashita, P. M. Reddy, Y. Kato, T. Oshikawa, and T. Kamiya (Shizuoka University).
48. "Development and Application of the Nazarov Reaction of Phosphonodivinyketones" by T. Okauchi, F. Nakamura, T. Adachi, N. Okabe, J. Ichikawa, T. Minami, and M. Ishida (Kyusyu Institute of Technology, Gifu University).
49. "An Efficient Generation of Trifluoroacetaldehyde and Its Synthetic Utilization *via* the Carbon-Carbon Bond Forming Reaction" by K. Funabiki, M. Nojiri, K. Matsunaga, M. Matsui, and K. Shibata (Gifu University).
50. "Diastereoselective Anodic Monofluorination of Open-Chain Sulfides" by T. Fuchigami and S. Furuta (Tokyo Institute of Technology).
51. "Structural Characteristics of Bismuth Phenoxides Bearing Hypervalent Bonds. Formation of a 1:1 Adduct with a Hydrogen Bond" by T. Murafuji, M. Nagasue, Y. Tashiro, and Y. Sugihara (Yamaguchi University).
52. "New Silylation Reactions of Olefins Using a Titanocene Catalyst" by J. Terao, K. Saito, S. Nii, N. Kambe, and N. Sonoda (Osaka University, Kansai University).
53. "A Development of New Synthetic Organic Reactions by Using Bismuth Compounds" by T. Fukuma, S. Nagayama, A. Tsuchiura, N. Miyoshi, and M. Wada (The University of Tokushima).

## Poster Presentations

1. "Reactions of Selenothioic Acid *S*-Esters and Diselenoic Acid Esters with Phosphorus Compounds" by C. Izumi, T. Murai, and S. Kato (Gifu University).

2. "Reaction of 2,3-Bis(trimethylsilyl)cyclopropanone with Phosphorus Ylides: Unexpected Formation of Silyl-Substituted Furanes" by A. Ogawa, T. Takanami, and K. Suda (Meiji Pharmaceutical University).
3. "Chiral Bis(oxazoline)-Copper Catalyzed Asymmetric Imidation of an Organic Selenide" by M. Oda, Y. Miyake, H. Takada, K. Ohe, and S. Uemura (Kyoto University).
4. "Molecular Bromine Inclusion in Selenanthrene Dibromide II: Br<sub>4</sub> 4c-6e Formation without Any Significant Se . . . Br Interaction" by W. Nakanishi, S. Hayashi, S. Yamaguchi, and K. Tamao (Wakayama University, Kyoto University).
5. "Selection of Peptides That Recognize DNA Tetraloops by Combinatorial Chemistry" by S. Okabe, M. Yoneyama, and N. Sugimoto (Konan University).
6. "Intramolecular Nonbonded Interaction between Antimony and N, O, S Atoms in Organoantimony(III, V) Compounds and Their Properties" by S. Yasuike, M. Ikoma, T. Tsuchiya, J. Kurita, and K. Yamaguchi (Hokuriku University, Chiba University).
7. "Construction of a Supramolecular Structure Using Thiaheterohelicenediol" by K. Tanaka, Y. Kitahara, M. Makihara, and H. Suzuki (Kyoto University).
8. "Development of Novel Chemoselective Dirhodium(II)-Catalyzed C-H Insertion Reaction of  $\alpha$ -Diazo- $\beta$ -keto- $\delta$ -silyloxysulfones and Application to the Synthesis of Carboxylic Nucleosides" by T. Yakura, K. Tanaka, Y. Morioka, T. Kitamura, A. Ueki, and M. Ikeda (Kyoto Pharmaceutical University).
9. "Novel Generation of Silacarbonyl Ylides by Trapping of Silylene with Carbonyl Compounds and Their Cycloaddition" by N. Sakai, T. Fukushima, S. Minakata, I. Ryu, and M. Komatsu (Osaka University).
10. "Cyclization of *N*-Alkyl(*o*-methyl)arenesulfonamides with Diacetoxyiodobenzene" by M. Katohgi, H. Togo, and M. Yokoyama (Chiba University).
11. "Reaction of Bismuthonium Ylides with  $\alpha$ -Dicarbonyl Compounds" by Y. Matano, M. M. Pahlman, and H. Suzuki (Kyoto University).
12. "Nucleophilic Aromatic Substitution of Hydrogen in Some Nitroarenes with *O*- and *S*-Nucleophiles" by T. Kawakami and H. Suzuki (Kyoto University).
13. "Synthesis and Cycloaddition of Highly Strained Cycloalkyne Precursors" by M. Kotani, T. Yokoyama, T. Kitamura, and Y. Fujiwara (Kyusyu University).
14. "Side-Chain Substitution Reaction on Alkyl Aromatic Compounds in *Kyodai*-Nitration: Interesting Side Reactions and Their Mechanistic Investigation" by M. Iwaya, N. Nonoyama, and H. Suzuki (Kyoto University).
15. "Copper-Mediated Nucleophilic Substitution of Halogenoalkynes with Heteroatom Nucleophiles" by H. Abe and H. Suzuki (Kyoto University).
16. "Molecular Spring: Helical  $\pi$ -Electronic System" by K. Tanaka, Y. Kitahara, Y. Yoda, and H. Suzuki (Kyoto University).
17. "*Ips*o-Attack and Side-Chain Substitution in Aromatic Nitration" by N. Nonoyama, M. Iwaya, and H. Suzuki (Kyoto University).
18. "Synthesis and Properties of New Thienylenevinylene Oligomers with Electron Donating Groups" by H. Okumura, T. Murashima, T. Ogawa, and N. Ono (Ehime University).
19. "Tellurium-Mediated Formation of Organometallic Compounds of Group II, XII, XIII Metals and Its Synthetic Application" by T. Meguro, J. Terao, N. Kambe, and N. Sonoda (Osaka University, Kansai University).
20. "Synthesis of Optically Active Helicenes Using Oxazoline Moiety as a Chiral Auxiliary" by K. Tanaka, H. Osugi, Y. Kitahara, T. Takimoto, and H. Suzuki (Kyoto University, Wakayama University).
21. "Synthesis and Properties of Thermally Stable Crystalline Inner Salts Having a 1,4-Dipolar Structure" by T. Kitahara, K. Akimoto, T. Otani, Y. Sugihara, A. Ishii, and J. Nakayama (Saitama University).
22. "Synthesis and Sulfonation of *syn*- and *anti*-Benzonorbornenylidenebenzonorbornenes" by K. Noda, Y. Sugihara, and J. Nakayama (Saitama University).
23. "Remote Pummerer Reaction Based on Intermolecular Through-Space Interaction between Sulfur Atoms" by K. Kobayashi, K. Namatame, T. Kitaura, E. Koyama, and N. Furukawa (University of Tsukuba).
24. "Synthesis and Structure of Organobismuth Alkoxides and Amides. Reaction with Platinum(0) Complexes and Application toward Organic Synthesis" by S. Shimada, M. L. N. Rao, and M. Tanaka (National Institute of Materials and Chemical Research, CREST).
25. "Oxidation Reaction of a Thiol Bearing a Novel *m*-Terphenyl-Based Steric Protection Group" by Y. Hino, K. Goto, and G. Yamamoto (Kitasato University).
26. "Synthesis and Reactions of a  $\beta$ -Phenylthiovi-

- nylselenonium Salt” by T. Kataoka, S. Watanabe, and E. Mori (Gifu Pharmaceutical University).
27. “Syntheses and Properties of Monothiacalixarenes” by K. Ito, Y. Ohba, and T. Sone (Yamagata University).
  28. “Palladium-Catalyzed Aryl Coupling of Triaryl-bismuthine” by T. Ohe, T. Tanaka, M. Kuroda, K. Ohe, and S. Uemura (Kyoto University).
  29. “Generation and Trapping of Allenylthio ketene S,S-Dioxides from Alkynyl Propargyl Sulfones” by S. Aoyagi, J. Murakami, K. Shimada, and Y. Takikawa (Iwate University).
  30. “Generation of Highly Reactive Species by Oxidation of Sterically Protected Thiones and Selenones” by K. Shimada, K. Kodaki, S. Aoyagi, and Y. Takikawa (Iwate University).
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