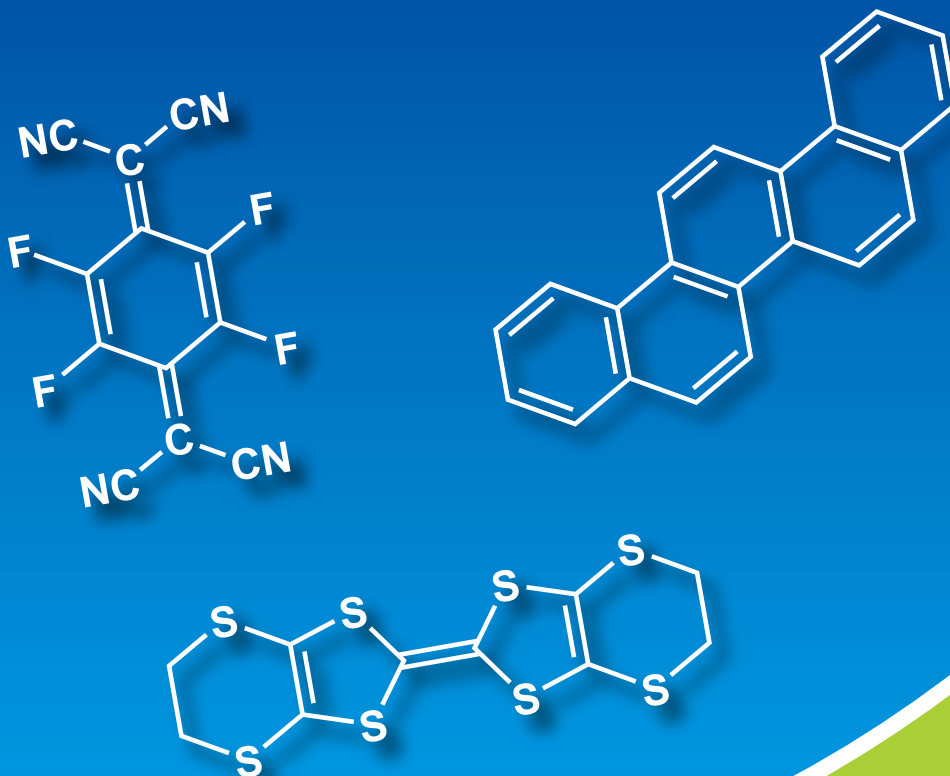


分子性導体

Molecular Conductors



アクセプター分子

ドナー分子

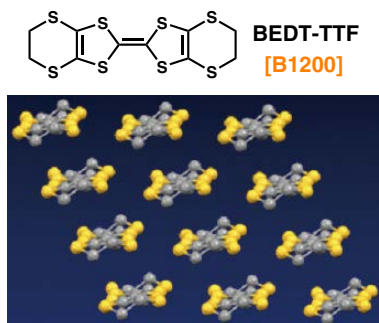
電解結晶化用支持電解質

テトラチアフルバレン (TTF) 中間体

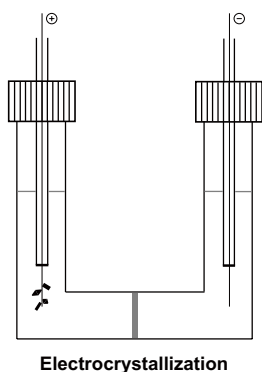
分子性導体

分子性導体は分子を構成成分とする電気伝導体で、化学的な分子修飾を基にその電子構造や物性を制御できる特徴があります。電子的に閉殻構造を持つ有機化合物は通常絶縁体ですが、これに化学的あるいは電気化学的にキャリアを導入することで、開殻構造を持った電気伝導体を作成することができます。有機導体の最初の例は、ペリレンに臭素をドーピングすることで見出されました¹⁾。その後、1970年代にテトラシアフルバレン (TTF) を構成成分とする分子性導体が報告され²⁾、1980年代には有機物で初めての超伝導体がテトラメチルテトラセナフルバレンの塩 (TMTSF)₂Xから発見されています³⁾。TTFやTMTSFは、一次元あるいは擬一次元の分子配列を形成します。一方、ビス (エチレンジチオ) テトラシアフルバレン (BEDT-TTF) は二次元の分子配列を形成しやすく、一次元系に比べると温度に対して安定な金属状態を保持しやすいことが知られています⁴⁻⁶⁾。

TTF類縁体の伝導体塩を作成するには、たいいていの場合において電解酸化による結晶化法 (電解結晶化法) が用いられます⁷⁾。これらのTTF類縁体はすべて正孔をキャリアとするドナー分子として機能しますが、金属ジチオレン錯体 (M(dmit)₂) や7,7,8,8-テトラシアノキノジメタン (TCNQ)、フラレーン (C₆₀) などは電子をキャリアとするアクセプター分子となります。M(dmit)₂の塩は、アクセプター性有機超伝導体としては最初の例で⁸⁾、中心金属や対カチオンの種類を変えることで、様々な超伝導体が報告されています⁹⁾。

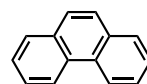


Molecular arrangement of BEDT-TTF salt (β-form)

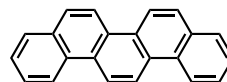


ナノカーボンおよびナノグラフェン化合物に対するアルカリ金属ドーピングによる超伝導体の報告例もあります。ルビジウムやセシウムをドーピングしたフラレーンが、30 K以上で超伝導転移を起こすことは以前から知られていました¹⁰⁾。近年では、38 Kで超伝導体となるC₈₃C₆₀が報告されています¹¹⁾。TTF類縁体やM(dmit)₂の伝導体が低次元の分子配列を示すのに対し、フラレーンの場合には三次元系であるという特徴があります¹²⁾。また、久保園らは、アルカリ金属をドーピングしたピセンが18 Kにおいて超伝導を発現することを見出しました¹³⁾。平面状のナノカーボン材料でも超伝導が起こることを示しています。ピセンの超伝導体の報告に次いで、アルカリ金属をドーピングしたフェナントレン (T_c = 5 K)¹⁴⁾やコロンネン (T_c = 15 K)¹⁵⁾、1,2:8,9-ジベンゾペンタセン (T_c = 33 K)¹⁶⁾でも超伝導が見出されています。

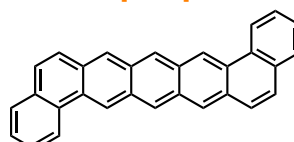
Superconducting materials by alkali metal doping



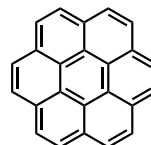
Phenanthrene
[P0079]



Picene
[P2207]



1,2:8,9-Dibenzopentacene
[D1311]



Coronene
[C0386][C1961]

文 献

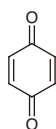
- 1) H. Akamatsu, H. Inokuchi, Y. Matsunaga, *Nature* **1954**, 173, 168.
- 2) F. Wudl, D. Wobschall, E. J. Hufnagel, *J. Am. Chem. Soc.* **1972**, 94, 670.
- 3) D. Jérôme, A. Mazaud, M. Ribault, K. Bechgaard, *J. Phys. Lett.* **1980**, 41, 95.
- 4) T. Mori, *Chem. Rev.* **2004**, 104, 4947.
- 5) R. P. Shibaeva, E. B. Yagubskii, *Chem. Rev.* **2004**, 104, 5347.
- 6) H. Mori, *Int. J. Mod. Phys. B* **1994**, 8, 1.
- 7) P. Batail, K. Boubekur, M. Fourmigué, J.-C. P. Gabriel, *Chem. Mater.* **1998**, 10, 3005.
- 8) L. Brossard, M. Ribault, M. Bousseau, L. Valade, P. Cassoux, *C. R. Acad. Sci., Ser. II*

1986, 302, 205.

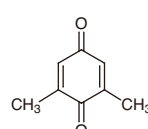
9) R. Kato, *Chem. Rev.* **2004**, 104, 5319.10) K. Tanigaki, T. W. Ebbesen, S. Saito, J. Mizuki, J. S. Tsai, Y. Kubo, S. Kuroshima, *Nature* **1991**, 352, 222.11) A. Y. Ganin, Y. Takabayashi, Y. Z. Khimyak, S. Margadonna, A. Tamai, M. J. Rosseinsky, K. Prassides, *Nat. Mater.* **2008**, 7, 367.12) Y. Takabayashi, A. Y. Ganin, P. Jeglič, D. Arčon, T. Takano, Y. Iwasa, Y. Ohishi, M. Takata, N. Takeshita, K. Prassides, M. J. Rosseinsky, *Science* **2009**, 323, 1585.13) R. Mitsuhashi, Y. Suzuki, Y. Yamanari, H. Mitamura, T. Kambe, N. Ikeda, H. Okamoto, A. Fujiwara, M. Yamaji, N. Kawasaki, Y. Maniwa, Y. Kubozono, *Nature* **2010**, 464, 76.14) X. F. Wang, R. H. Liu, Z. Gui, Y. L. Xie, Y. J. Yan, J. J. Ying, X. G. Luo, X. H. Chen, *Nat. Commun.* **2011**, 2, 1513.15) Y. Kubozono, H. Mitamura, X. Lee, X. He, Y. Yamanari, Y. Takahashi, Y. Suzuki, Y. Kaji, R. Eguchi, K. Akaike, T. Kambe, H. Okamoto, A. Fujiwara, T. Kato, T. Kosugi, H. Aoki, *Phys. Chem. Chem. Phys.* **2011**, 13, 16476.16) M. Xue, T. Cao, D. Wang, Y. Wu, H. Yang, X. Dong, J. He, F. Li, G. F. Chen, *Sci. Rep.* **2012**, 2, srep00389.

アクセプター分子

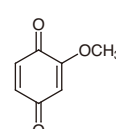
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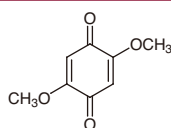
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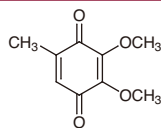
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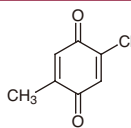
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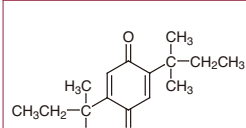
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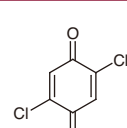
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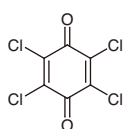
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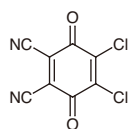
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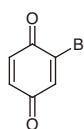
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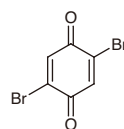
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DDQ
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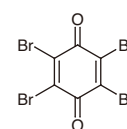
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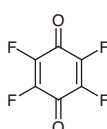
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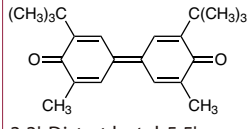
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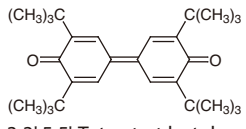
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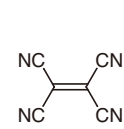
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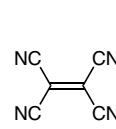
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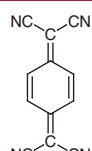
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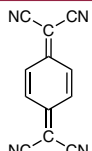
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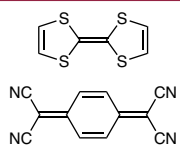
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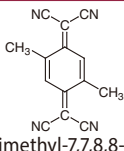
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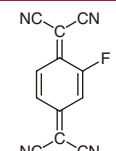
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TTF - TCNQ Complex
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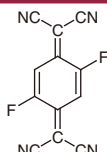
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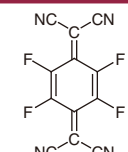
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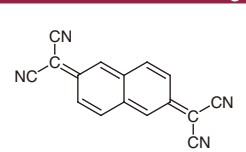
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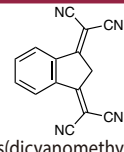
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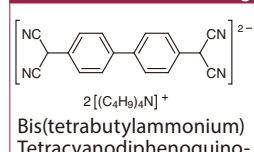
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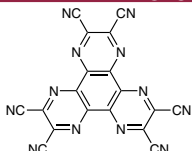
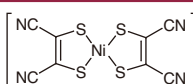
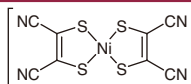
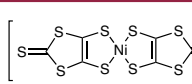
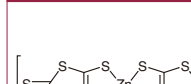
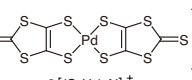
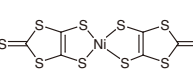
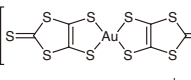
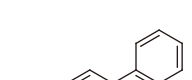
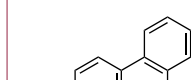
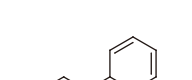
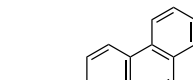
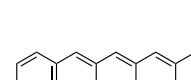
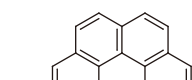
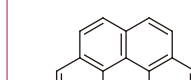
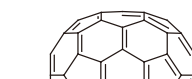
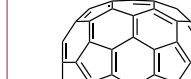
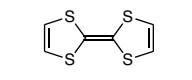
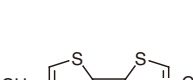
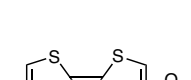
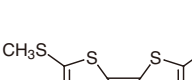
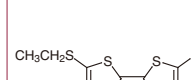
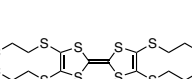
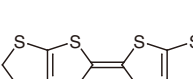
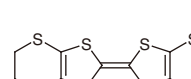
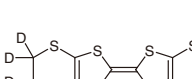
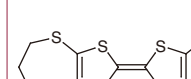
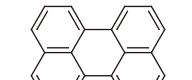
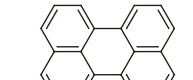
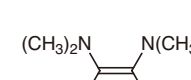
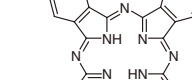
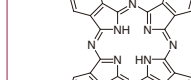
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CAS RN: 6251-01-0

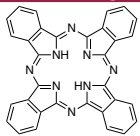
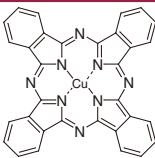
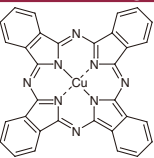
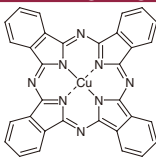
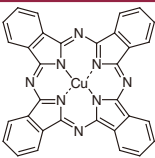
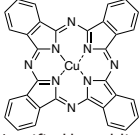
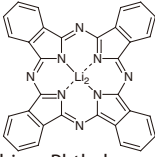
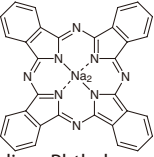
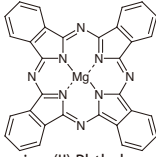
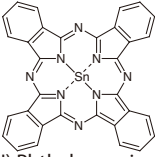
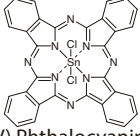
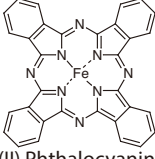
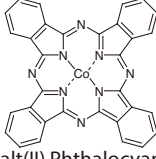
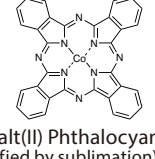
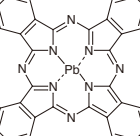
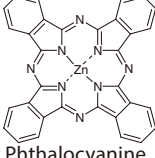
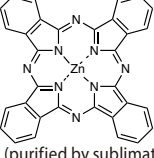
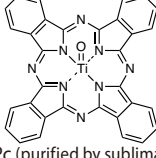
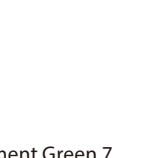
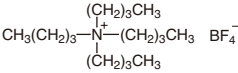
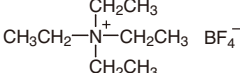
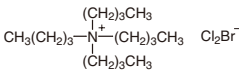
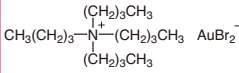
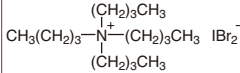
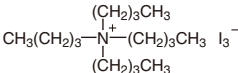
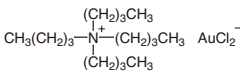
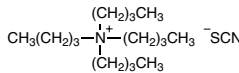
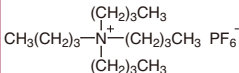
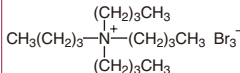
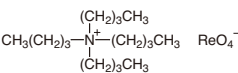
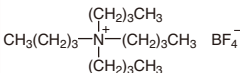
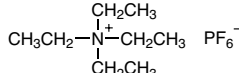
B1416 1g 5g

1,3-Bis(dicyanomethylidene)-indan
CAS RN: 38172-19-9

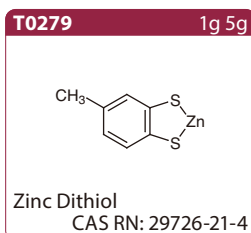
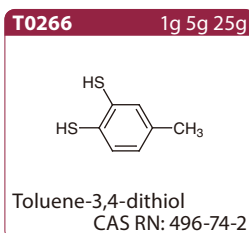
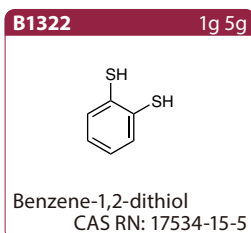
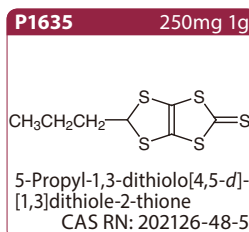
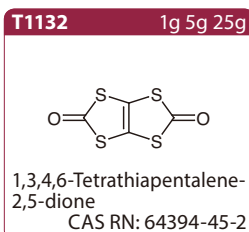
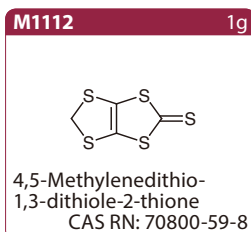
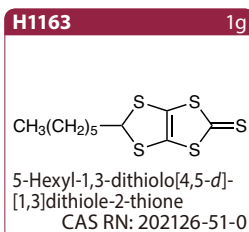
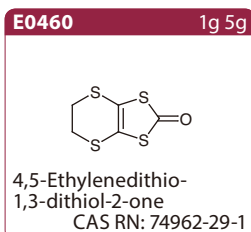
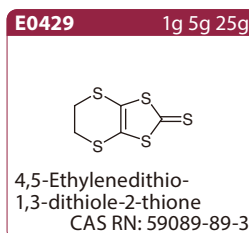
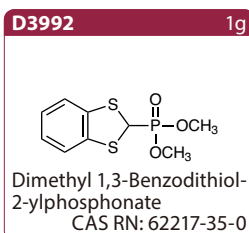
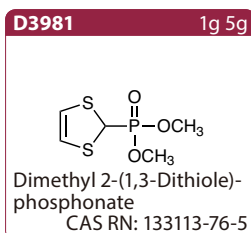
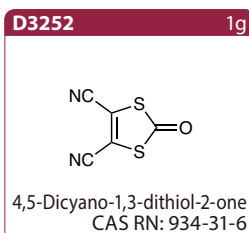
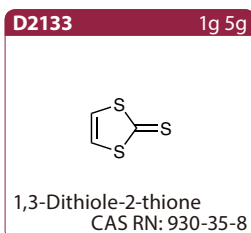
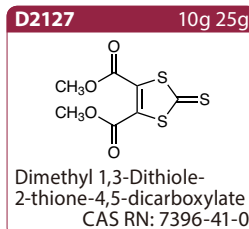
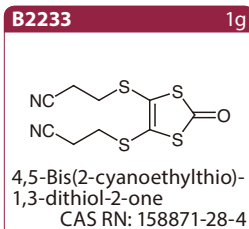
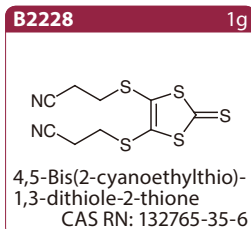
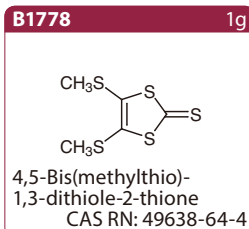
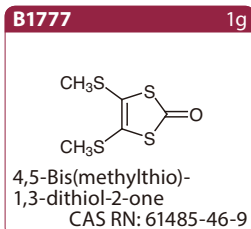
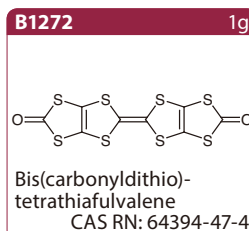
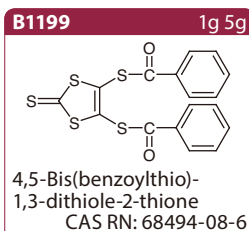
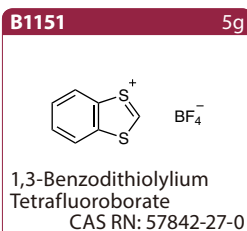
B1466 100mg

Bis(tetrabutylammonium) Tetracyanodiphenylquinodimethanide
CAS RN: 68271-98-7

D5248 200mg 1g 5g  HAT-CN 6 CAS RN: 105598-27-4	T1415 1g  (C ₄ H ₉) ₄ N ⁺ Tetrabutylammonium Bis(maleonitriledithiolato)- nickel(III) Complex CAS RN: 55401-12-2	B1371 1g  2 [(C ₄ H ₉) ₄ N] ⁺ Bis(tetrabutylammonium) Bis(maleonitriledithiolato)- nickel(II) Complex CAS RN: 18958-57-1	T1272 100mg  (C ₄ H ₉) ₄ N ⁺ Tetrabutylammonium Bis(1,3-dithiole-2-thione-4,5- dithiolato)nickel(III) Complex CAS RN: 68401-88-7	B1221 5g 25g  2 [(C ₄ H ₉) ₄ N] ⁺ BTBA-BDTD Zn Complex CAS RN: 68449-38-7
B1437 100mg 1g  2 [(C ₄ H ₉) ₄ N] ⁺ Bis(tetrabutylammonium) Bis(1,3-dithiole-2-thione- 4,5-dithiolato)palladium(II) CAS RN: 72688-90-5	T1416 1g  (C ₄ H ₉) ₄ P ⁺ Tetrabutylphosphonium Bis(1,3-dithiole-2-thione-4,5- dithiolato)nickel(III) Complex CAS RN: 105029-70-7	D2134 100mg  (C ₁₈ H ₃₇) ₂ (CH ₃) ₂ N ⁺ Dioctadecyldimethylammonium Bis(1,3-dithiole-2-thione- 4,5-dithiolato)aurate(III) CAS RN: 120141-26-6	P0079 25g 500g  Phenanthrene CAS RN: 85-01-8	P2877 5g 25g  Phenanthrene (purified by sublimation) CAS RN: 85-01-8
P0331 1sample  Phenanthrene Zone Refined (number of passes:30) CAS RN: 85-01-8	P2207 100mg 500mg  Picene (purified by sublimation) (>99.9%) CAS RN: 213-46-7	D5488 100mg  Dibenzo[a,l]pentacene CAS RN: 227-09-8	C0386 1g 5g  Coronene CAS RN: 191-07-1	C1961 100mg  Coronene (purified by sublimation) CAS RN: 191-07-1
B1660 100mg 1g  Fullerene C ₆₀ CAS RN: 99685-96-8	B1641 100mg 500mg 1g  Fullerene C ₆₀ (pure) CAS RN: 99685-96-8	F1232 100mg  Fullerene C ₆₀ [for organic electronics] CAS RN: 99685-96-8	B1694 100mg  Fullerene C ₇₀ CAS RN: 115383-22-7	F1233 100mg  Fullerene C ₇₀ [for organic electronics] CAS RN: 115383-22-7
ドナー分子				
T2468 1g  TTF - TCNQ Complex CAS RN: 40210-84-2	D2067 100mg 1g  SDM-TTF	F0285 1g  Formyl-TTF CAS RN: 68128-94-9	T1119 100mg  TMT-TTF CAS RN: 51501-77-0	T1571 100mg  TET-TTF CAS RN: 104515-79-9
T2806 100mg  2,3,6,7-Tetrakis(2- cyanoethylthio)- tetrathiafulvalene CAS RN: 132765-36-7	B1218 100mg  BMDT-TTF CAS RN: 68550-20-9	B1200 100mg 1g 5g  BEDT-TTF CAS RN: 66946-48-3	B1299 100mg  BEDT-TTF-d ₈ CAS RN: 101751-48-8	B1244 100mg  BPDT-TTF CAS RN: 66946-49-4
P0078 1g 5g 25g  Perylene CAS RN: 198-55-0	P1629 1g  Perylene (purified by sublimation) CAS RN: 198-55-0	T1221 5g 25g  TDAE CAS RN: 996-70-3	P0355 25g  Phthalocyanine CAS RN: 574-93-6	P1795 1g  Phthalocyanine (purified by sublimation) CAS RN: 574-93-6

P2734 100mg 500mg  Phthalocyanine (purified by sublimation) [for organic electronics] CAS RN: 574-93-6	P0655 25g  CuPc CAS RN: 147-14-8	P1005 25g 250g  CuPc (α-form) CAS RN: 147-14-8	P1006 25g 100g 500g  CuPc (β-form) CAS RN: 147-14-8	P1628 1g  CuPc (purified by sublimation) CAS RN: 147-14-8
C3645 100mg 500mg  CuPc (purified by sublimation) [for organic electronics] CAS RN: 147-14-8	P1049 1g  Dilithium Phthalocyanine CAS RN: 25510-41-2	P0973 1g 5g  Disodium Phthalocyanine CAS RN: 25476-27-1	P1018 1g  Magnesium(II) Phthalocyanine CAS RN: 1661-03-6	P1024 1g 5g  Tin(II) Phthalocyanine CAS RN: 15304-57-1
P0997 1g  Tin(IV) Phthalocyanine Dichloride CAS RN: 18253-54-8	P0774 5g 25g  Iron(II) Phthalocyanine CAS RN: 132-16-1	I0783 200mg 1g  Iron(II) Phthalocyanine (purified by sublimation) CAS RN: 132-16-1	P0887 5g 25g  Cobalt(III) Phthalocyanine CAS RN: 3317-67-7	C3252 200mg  Cobalt(II) Phthalocyanine (purified by sublimation) CAS RN: 3317-67-7
P0766 1g 25g  Lead(II) Phthalocyanine CAS RN: 15187-16-3	P0767 1g 5g 25g  Zinc Phthalocyanine CAS RN: 14320-04-8	Z0037 500mg  ZnPc (purified by sublimation) CAS RN: 14320-04-8	T2272 200mg 1g  TiOPc (purified by sublimation) CAS RN: 26201-32-1	P0660 25g  Pigment Green 7 CAS RN: 1328-53-6
電解結晶化用支持電解質				
T0914 25g 100g 500g  Tetrabutylammonium Tetrafluoroborate CAS RN: 429-42-5	T0983 5g 25g  Tetraethylammonium Tetrafluoroborate CAS RN: 429-06-1	T1186 25g  Tetrabutylammonium Dichlorobromide CAS RN: 13053-75-3	T1261 1g  Tetrabutylammonium Dibromaurate CAS RN: 50481-01-1	T1269 1g 10g  Tetrabutylammonium Dibromiodide CAS RN: 15802-00-3
T1271 5g 25g  Tetrabutylammonium Triiodide CAS RN: 13311-45-0	T1273 100mg  Tetrabutylammonium Dichloraurate CAS RN: 50480-99-4	T1278 25g 250g  Tetrabutylammonium Thiocyanate CAS RN: 3674-54-2	T1279 25g 250g  Tetrabutylammonium Hexafluorophosphate CAS RN: 3109-63-5	T1284 25g 100g 500g  Tetrabutylammonium Tribromide CAS RN: 38932-80-8
T1803 1g 5g  Tetrabutylammonium Perrhenate CAS RN: 16385-59-4	T2648 25g  Tetrabutylammonium Tetrafluoroborate CAS RN: 429-42-5	T3659 5g 25g  Tetraethylammonium Hexafluorophosphate CAS RN: 429-07-2		

テトラチアフルバレン (TTF)中間体



東京化成工業株式会社

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Tel: 03-3668-0489 Fax: 03-3668-0520 E-mail: Sales-JP@TCIchemicals.com

■大 阪 営 業 部 〒541-0041 大阪府大阪市中央区北浜 1-1-21 第2中井ビル1階
Tel: 06-6228-1155 Fax: 06-6228-1158 E-mail: osaka-s@TCIchemicals.com

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□化成品営業部 〒103-0001 東京都中央区日本橋小伝馬町 16-12 T-PLUS 日本橋小伝馬町8階
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