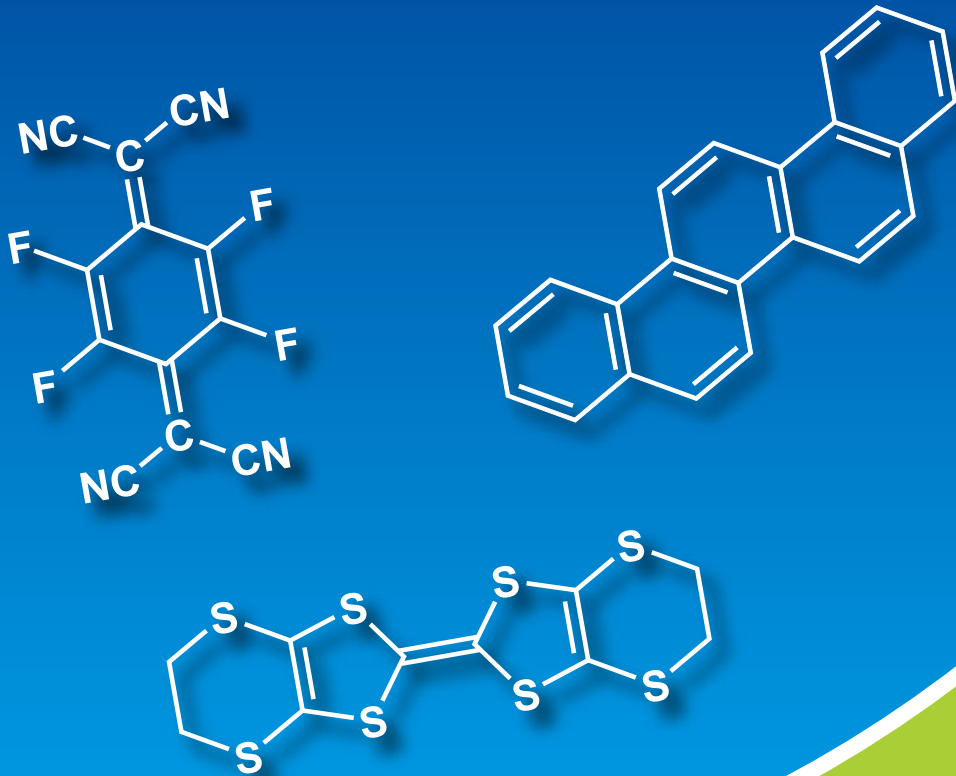


# 分子性導体

Molecular Conductors



アクセプター分子

ドナー分子

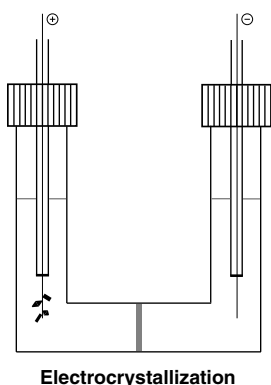
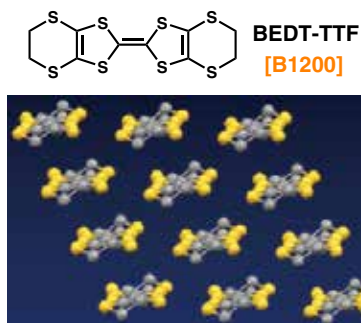
電解結晶化用支持電解質

テトラチアフルバレン (TTF) 中間体

# 分子性導体

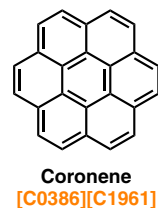
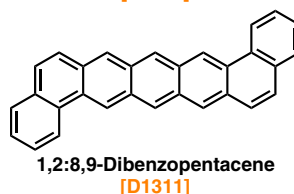
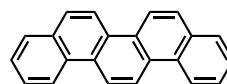
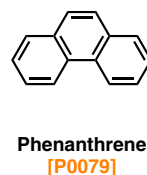
分子性導体は分子を構成成分とする電気伝導体で、化学的な分子修飾を基にその電子構造や物性を制御できる特徴があります。電子的に閉殻構造を持つ有機化合物は通常絶縁体ですが、これに化学的あるいは電気化学的にキャリアを導入することで、開殻構造を持った電気伝導体を作成することができます。有機導体の最初の例は、ペリレンに臭素をドーピングすることで見出されました<sup>1)</sup>。その後、1970年代にテトラシアフルバレン (TTF) を構成成分とする分子性導体が報告され<sup>2)</sup>、1980年代には有機物で初めての超伝導体がテトラメチルテトラセナフルバレンの塩(TMTSF)<sub>2</sub>Xから発見されています<sup>3)</sup>。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<sup>4-6)</sup>。

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<sup>7)</sup>。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)<sub>2</sub>)や7,7,8,8-テトラシアノキノジメタン(TCNQ)、フラレーン(C<sub>60</sub>)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)<sub>2</sub>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<sup>8)</sup>、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<sup>9)</sup>。



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<sup>10)</sup>。近年では、38 Kで超伝導体となるC<sub>59</sub>C<sub>60</sub>が報告されています<sup>11)</sup>。TTF類縁体やM(dmit)<sub>2</sub>の伝導体が低次元の分子配列を示すのに対し、フラレーンの場合は三次元系であるという特徴があります<sup>12)</sup>。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<sup>13)</sup>。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(Tc = 5 K)<sup>14)</sup>やコロネン(Tc = 15 K)<sup>15)</sup>、1,2:8,9-ジベンゾペンタセン(Tc = 33 K)<sup>16)</sup>でも超伝導が見出されています。

## Superconducting materials by alkali metal doping

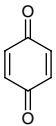
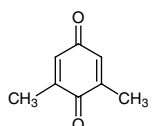
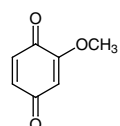
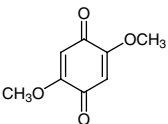
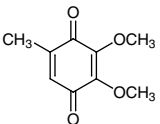
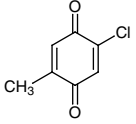
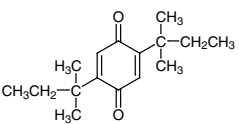
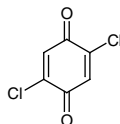
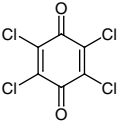
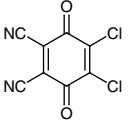
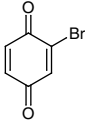
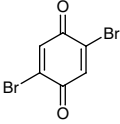
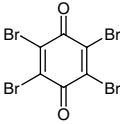
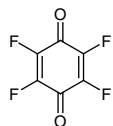
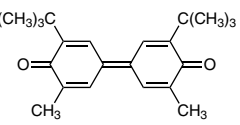
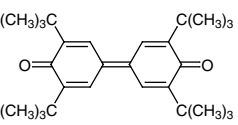
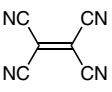
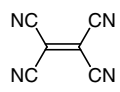
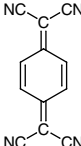
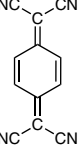
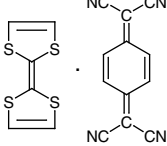
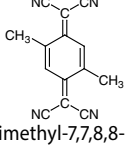
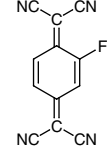
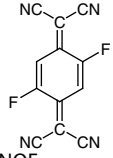
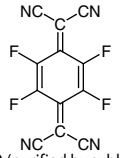
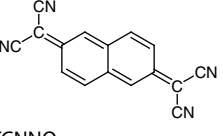
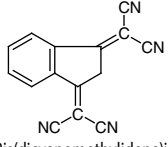
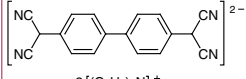


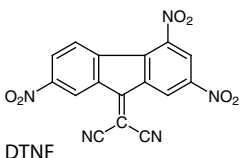
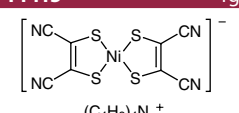
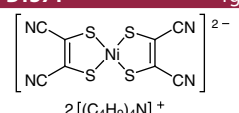
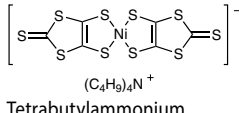
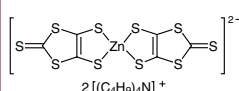
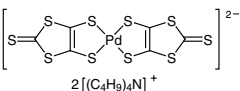
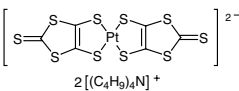
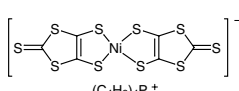
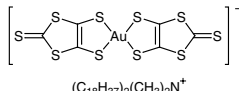
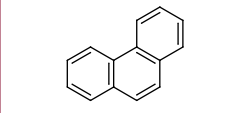
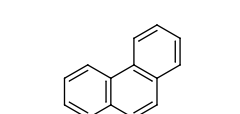
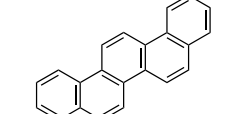
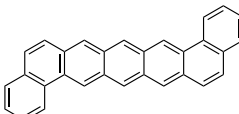
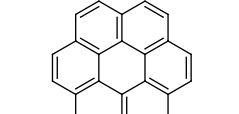
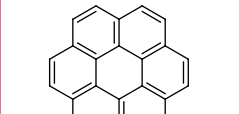




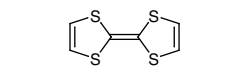
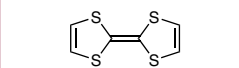
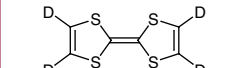
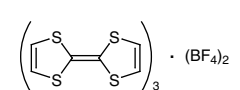
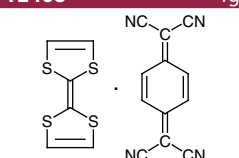
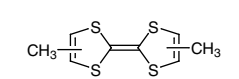
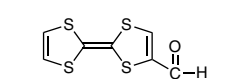
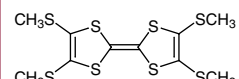
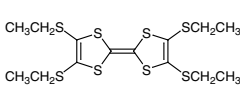
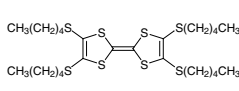
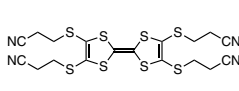
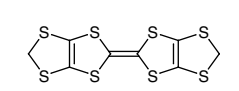
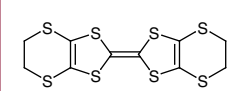
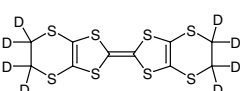
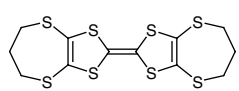
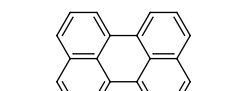
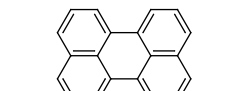
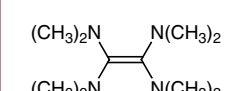
## 文献

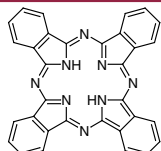
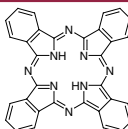
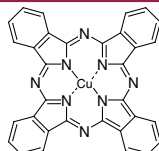
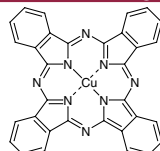
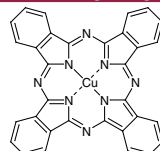
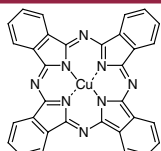
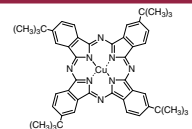
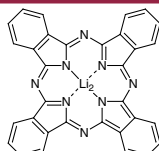
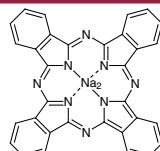
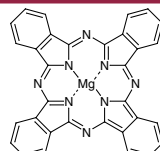
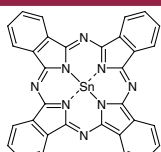
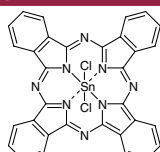
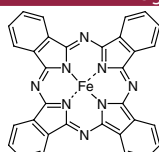
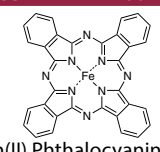
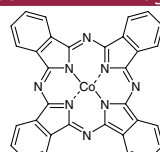
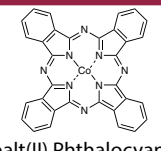
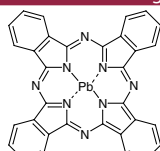
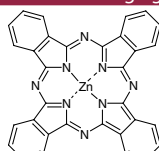
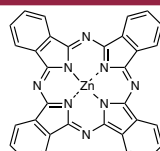
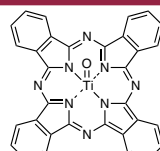

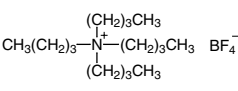
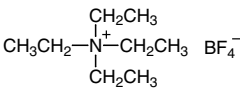
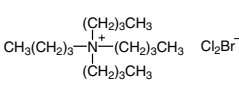
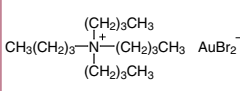
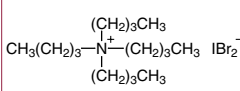
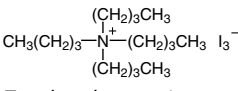
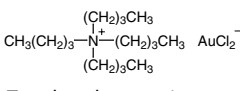
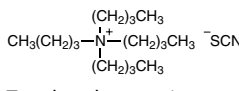
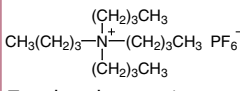
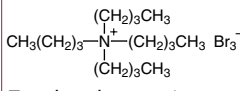
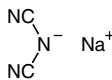
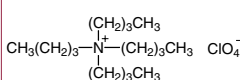
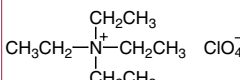
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## アクセプター分子

	<b>B0089</b> 25g 100g 500g  1,4-Benzoquinone CAS RN: 106-51-4	<b>D2234</b> 1g 5g 25g  2,6-Dimethyl-1,4-benzoquinone CAS RN: 527-61-7	<b>M1045</b> 1g 5g  Methoxybenzoquinone CAS RN: 2880-58-2	
<b>D2250</b> 5g 25g  2,5-Dimethoxy-1,4-benzoquinone CAS RN: 3117-03-1	<b>D1956</b> 1g 5g  Coenzyme Qo CAS RN: 605-94-7	<b>C1336</b> 5g  2-Chloro-5-methyl-1,4-benzoquinone CAS RN: 19832-87-2	<b>D2152</b> 5g  2,5-Di-tert-amylbenzoquinone CAS RN: 4584-63-8	<b>D0343</b> 1g 5g  2,5-Dichloro-1,4-benzoquinone CAS RN: 615-93-0
<b>T0061</b> 25g 500g  Chloranil CAS RN: 118-75-2	<b>D1070</b> 25g 250g  DDQ CAS RN: 84-58-2	<b>B1601</b> 1g 5g  2-Bromo-1,4-benzoquinone CAS RN: 3958-82-5	<b>D2249</b> 1g 5g  2,5-Dibromo-1,4-benzoquinone CAS RN: 1633-14-3	<b>T0617</b> 5g 25g  Bromanil CAS RN: 488-48-2
<b>T0790</b> 1g 5g  Fluoranil CAS RN: 527-21-9	<b>D4407</b> 1g  3,3'-Di-tert-butyl-5,5'-dimethyldiphenquinone CAS RN: 2417-00-7	<b>T1503</b> 1g  3,3',5,5'-Tetra-tert-butyl-4,4'-diphenquinone CAS RN: 2455-14-3	<b>T3264</b> 1g 5g  TCNE (purified by sublimation) CAS RN: 670-54-2	<b>T0077</b> 5g 25g  Tetracyanoethylene CAS RN: 670-54-2
<b>T0078</b> 5g 25g  TCNQ CAS RN: 1518-16-7	<b>T3034</b> 1g 5g  TCNQ (purified by sublimation) CAS RN: 1518-16-7	<b>T2468</b> 1g  TTF - TCNQ Complex CAS RN: 40210-84-2	<b>D2021</b> 100mg 500mg  2,5-Dimethyl-7,7,8,8-tetracyanoquinodimethane CAS RN: 1487-82-7	<b>F0509</b> 100mg  FTCNQ CAS RN: 69857-37-0
<b>D3200</b> 100mg  2,5-TCNQF <sub>2</sub> CAS RN: 73318-02-2	<b>T1131</b> 100mg 1g  F <sub>4</sub> TCNQ (purified by sublimation) CAS RN: 29261-33-4	<b>T1246</b> 100mg  TCNNO CAS RN: 6251-01-0	<b>B1416</b> 1g 5g  1,3-Bis(dicyanomethylidene)indan CAS RN: 38172-19-9	<b>B1466</b> 100mg  Bis(tetrabutylammonium) Tetracyanodiphenylquinodimethane CAS RN: 68271-98-7

<p><b>T0875</b> 1g 5g</p>  <p>DTNF CAS RN: 1172-02-7</p>	<p><b>T1415</b> 1g</p>  <p>(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>N<sup>+</sup> Tetrabutylammonium Bis(maleonitriledithiolato)nickel(III) Complex CAS RN: 6251-01-0</p>	<p><b>B1371</b> 1g</p>  <p>2 [(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>N]<sup>+</sup> Bis(tetrabutylammonium) Bis(maleonitriledithiolato)nickel(II) Complex CAS RN: 18958-57-1</p>	<p><b>T1272</b> 100mg</p>  <p>(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>N<sup>+</sup> Tetrabutylammonium Bis(1,3-dithiole-2-thione-4,5-dithiolato)nickel(III) Complex CAS RN: 68401-88-7</p>	<p><b>B1221</b> 5g 25g</p>  <p>2 [(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>N]<sup>+</sup> BTBA-BDTD Zn Complex CAS RN: 68449-38-7</p>
<p><b>B1437</b> 1g 5g</p>  <p>2 [(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>N]<sup>+</sup> Bis(tetrabutylammonium) Bis(1,3-dithiole-2-thione-4,5-dithiolato)palladium(II) Complex CAS RN: 72688-90-5</p>	<p><b>B1438</b> 100mg</p>  <p>2 [(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>N]<sup>+</sup> Bis(tetrabutylammonium) Bis(1,3-dithiole-2-thione-4,5-dithiolato)platinum(II) Complex CAS RN: 72688-91-6</p>	<p><b>T1416</b> 1g</p>  <p>(C<sub>4</sub>H<sub>9</sub>)<sub>4</sub>P<sup>+</sup> Tetrabutylphosphonium Bis(1,3-dithiole-2-thione-4,5-dithiolato)nickel(III) Complex CAS RN: 105029-70-7</p>	<p><b>D2134</b> 100mg 500mg</p>  <p>(C<sub>18</sub>H<sub>37</sub>)<sub>2</sub>(CH<sub>3</sub>)<sub>2</sub>N<sup>+</sup> Dioctadecyldimethylammonium Bis(1,3-dithiole-2-thione-4,5-dithiolato)aurate(III) Complex CAS RN: 120141-26-6</p>	<p><b>P0079</b> 25g 500g</p>  <p>Phenanthrene CAS RN: 85-01-8</p>
<p><b>P0331</b> 1sample</p>  <p>Phenanthrene Zone Refined (number of passes:30) CAS RN: 85-01-8</p>	<p><b>P2207</b> 100mg</p>  <p>Picene (purified by sublimation) (&gt;99.9%) CAS RN: 213-46-7</p>	<p><b>D5488</b> 100mg</p>  <p>Dibenz[a,h]pentacene CAS RN: 227-09-8</p>	<p><b>C0386</b> 1g 5g</p>  <p>Coronene CAS RN: 191-07-1</p>	<p><b>C1961</b> 100mg</p>  <p>Coronene (purified by sublimation) CAS RN: 191-07-1</p>
<p><b>B1660</b> 100mg 1g</p>  <p>Fullerene C<sub>60</sub> CAS RN: 99685-96-8</p>	<p><b>B1641</b> 100mg 1g</p>  <p>Fullerene C<sub>60</sub> (pure) CAS RN: 99685-96-8</p>	<p><b>B1694</b> 100mg</p>  <p>Fullerene C<sub>70</sub> CAS RN: 115383-22-7</p>	<p><b>F1233</b> 100mg</p>  <p>Fullerene C<sub>70</sub> (for organic electronics) CAS RN: 115383-22-7</p>	
<p><b>ドナー分子</b></p>				
		<p><b>T0980</b> 1g 5g 25g</p>  <p>Tetrathiafulvalene CAS RN: 31366-25-3</p>	<p><b>T3380</b> 200mg 1g</p>  <p>TTF (purified by sublimation) CAS RN: 31366-25-3</p>	<p><b>T1377</b> 100mg</p>  <p>Tetrathiafulvalene-d<sub>4</sub> CAS RN: 51751-16-7</p>
<p><b>T1282</b> 1g</p>  <p>Tetrathiafulvalene Fluoroborate CAS RN: 55492-86-9</p>	<p><b>T2468</b> 1g</p>  <p>TTF - TCNQ Complex CAS RN: 40210-84-2</p>	<p><b>D2067</b> 100mg 1g</p>  <p>SDM-TTF</p>	<p><b>F0285</b> 1g</p>  <p>Formyl-TTF CAS RN: 68128-94-9</p>	<p><b>T1119</b> 100mg</p>  <p>TMT-TTF CAS RN: 51501-77-0</p>
<p><b>T1571</b> 100mg</p>  <p>TET-TTF CAS RN: 104515-79-9</p>	<p><b>T1205</b> 100mg</p>  <p>TPT-TTF CAS RN: 106920-29-0</p>	<p><b>T2806</b> 100mg</p>  <p>2,3,6,7-Tetrakis(2-cyanoethyl)tetrathiafulvalene CAS RN: 132765-36-7</p>	<p><b>B1218</b> 100mg</p>  <p>BMDT-TTF CAS RN: 68550-20-9</p>	<p><b>B1200</b> 100mg 1g 5g</p>  <p>BEDT-TTF CAS RN: 66946-48-3</p>
<p><b>B1299</b> 100mg</p>  <p>BEDT-TTF-d<sub>8</sub> CAS RN: 101751-48-8</p>	<p><b>B1244</b> 100mg</p>  <p>BPDT-TTF CAS RN: 66946-49-4</p>	<p><b>P0078</b> 5g 25g</p>  <p>Perylene CAS RN: 198-55-0</p>	<p><b>P1629</b> 1g</p>  <p>Perylene (purified by sublimation) CAS RN: 198-55-0</p>	<p><b>T1221</b> 5g 25g</p>  <p>TDAE CAS RN: 996-70-3</p>

<b>P0355</b> 25g  Phthalocyanine CAS RN: 574-93-6	<b>P1795</b> 1g  Phthalocyanine (purified by sublimation) CAS RN: 574-93-6	<b>P0655</b> 25g  Pigment Blue 15 CAS RN: 147-14-8	<b>P1005</b> 25g 250g  CuPc ( $\alpha$ -form) CAS RN: 147-14-8	<b>P1006</b> 25g 100g 500g  CuPc ( $\beta$ -form) CAS RN: 147-14-8
<b>P1628</b> 1g  CuPc (purified by sublimation) CAS RN: 147-14-8	<b>T1256</b> 100mg  Copper(II) 2,9,16,23-Tetra- <i>tert</i> -butylphthalocyanine CAS RN: 39001-64-4	<b>P1049</b> 1g 5g  Dilithium Phthalocyanine CAS RN: 25510-41-2	<b>P0973</b> 1g 5g  Disodium Phthalocyanine CAS RN: 25476-27-1	<b>P1018</b> 1g  Magnesium(II) Phthalocyanine CAS RN: 1661-03-6
<b>P1024</b> 1g 5g  Tin(II) Phthalocyanine CAS RN: 15304-57-1	<b>P0997</b> 1g  Tin(IV) Phthalocyanine Dichloride CAS RN: 18253-54-8	<b>P0774</b> 5g 25g  Iron(II) Phthalocyanine CAS RN: 132-16-1	<b>I0783</b> 200mg 1g  Iron(II) Phthalocyanine (purified by sublimation) CAS RN: 132-16-1	<b>P0887</b> 5g 25g  Cobalt(II) Phthalocyanine CAS RN: 3317-67-7
<b>C3252</b> 200mg  Cobalt(II) Phthalocyanine (purified by sublimation) CAS RN: 3317-67-7	<b>P0766</b> 1g 25g  Lead(II) Phthalocyanine CAS RN: 15187-16-3	<b>P0767</b> 1g 5g 25g  Zinc Phthalocyanine CAS RN: 14320-04-8	<b>Z0037</b> 500mg  ZnPc (purified by sublimation) CAS RN: 14320-04-8	<b>T2272</b> 200mg 1g  TiOPc (purified by sublimation) CAS RN: 26201-32-1
<b>P0660</b> 25g  Pigment Green 7 CAS RN: 1328-53-6				
<b>電解結晶化用支持電解質</b>				
<b>T0914</b> 25g 100g 500g  Tetrabutylammonium Tetrafluoroborate CAS RN: 429-42-5	<b>T0983</b> 5g 25g  Tetraethylammonium Tetrafluoroborate CAS RN: 429-06-1	<b>T1186</b> 25g  Tetrabutylammonium Dichlorobromide CAS RN: 13053-75-3	<b>T1261</b> 1g  Tetrabutylammonium Dibromoaurate CAS RN: 50481-01-1	<b>T1269</b> 1g 10g  Tetrabutylammonium Dibromiodide CAS RN: 15802-00-3
<b>T1271</b> 5g 25g  Tetrabutylammonium Triiodide CAS RN: 13311-45-0	<b>T1273</b> 100mg  Tetrabutylammonium Dichloroaurate CAS RN: 50480-99-4	<b>T1278</b> 25g 250g  Tetrabutylammonium Thiocyanate CAS RN: 3674-54-2	<b>T1279</b> 25g 250g  Tetrabutylammonium Hexafluorophosphate CAS RN: 3109-63-5	<b>T1284</b> 25g 100g 500g  Tetrabutylammonium Tribromide CAS RN: 38932-80-8
<b>S0838</b> 25g 100g  Sodium Dicyanamide CAS RN: 1934-75-4	<b>T0836</b> 25g 100g 500g  Tetrabutylammonium Perchlorate CAS RN: 1923-70-2	<b>T0839</b> 25g  Tetraethylammonium Perchlorate CAS RN: 2567-83-1		

<p><b>T1357</b> 100mg 1g</p> <p>Tetrabutylammonium Diiodoaurate</p>	<p><b>T1803</b> 1g 5g</p> <p>Tetrabutylammonium Perrhenate CAS RN: 16385-59-4</p>	<p><b>T2648</b> 25g</p> <p>Tetrabutylammonium Tetrafluoroborate CAS RN: 429-42-5</p>		
<p><b>テトラチアフルバレン (TTF)中間体</b></p>				
	<p><b>B1151</b> 5g</p> <p>1,3-Benzodithiolium Tetrafluoroborate CAS RN: 57842-27-0</p>	<p><b>B1199</b> 1g 5g</p> <p>4,5-Bis(benzoylthio)- 1,3-dithiole-2-thione CAS RN: 68494-08-6</p>	<p><b>B1272</b> 1g</p> <p>Bis(carbonyldithio) tetrathiafulvalene CAS RN: 64394-47-4</p>	
<p><b>B1777</b> 1g</p> <p>4,5-Bis(methylthio)- 1,3-dithiole-2-one CAS RN: 61485-46-9</p>	<p><b>B1778</b> 1g</p> <p>4,5-Bis(methylthio)- 1,3-dithiole-2-thione CAS RN: 49638-64-4</p>	<p><b>B2228</b> 1g</p> <p>4,5-Bis(2-cyanoethylthio)- 1,3-dithiole-2-thione CAS RN: 132765-35-6</p>	<p><b>B2233</b> 1g</p> <p>4,5-Bis(2-cyanoethylthio)- 1,3-dithiole-2-one CAS RN: 158871-28-4</p>	<p><b>D2127</b> 10g 25g</p> <p>Dimethyl 1,3-Dithiole- 2-thione-4,5-dicarboxylate CAS RN: 7396-41-0</p>
<p><b>D2133</b> 1g 5g</p> <p>1,3-Dithiole-2-thione CAS RN: 930-35-8</p>	<p><b>D3252</b> 1g</p> <p>4,5-Dicyano-1,3-dithiole-2-one CAS RN: 934-31-6</p>	<p><b>D3981</b> 1g 5g</p> <p>Dimethyl 2-(1,3-Dithiole)- phosphonate CAS RN: 133113-76-5</p>	<p><b>D3992</b> 1g</p> <p>Dimethyl 1,3-Benzodithiol- 2-ylphosphonate CAS RN: 62217-35-0</p>	<p><b>E0429</b> 1g 5g 25g</p> <p>4,5-Ethylenedithio- 1,3-dithiole-2-thione CAS RN: 59089-89-3</p>
<p><b>E0460</b> 1g 5g</p> <p>4,5-Ethylenedithio- 1,3-dithiole-2-one CAS RN: 74962-29-1</p>	<p><b>H1163</b> 1g</p> <p>5-Hexyl-1,3-dithiole[4,5-<i>d</i>]- [1,3]dithiole-2-thione CAS RN: 202126-51-0</p>	<p><b>M1112</b> 1g</p> <p>4,5-Methylenedithio- 1,3-dithiole-2-thione CAS RN: 70800-59-8</p>	<p><b>M1154</b> 100mg</p> <p>4,5-Methylenedithio- 1,3-dithiole-2-one CAS RN: 85720-62-3</p>	<p><b>P1635</b> 250mg 1g</p> <p>5-Propyl-1,3-dithiole[4,5-<i>d</i>]- [1,3]dithiole-2-thione CAS RN: 202126-48-5</p>
<p><b>T0266</b> 1g 5g 25g</p> <p>Toluene-3,4-dithiol CAS RN: 496-74-2</p>	<p><b>T0279</b> 1g 5g</p> <p>Zinc Dithiol CAS RN: 29726-21-4</p>	<p><b>T1132</b> 1g 5g 25g</p> <p>1,3,4,6-Tetrathiapentalene- 2,5-dione CAS RN: 64394-45-2</p>		

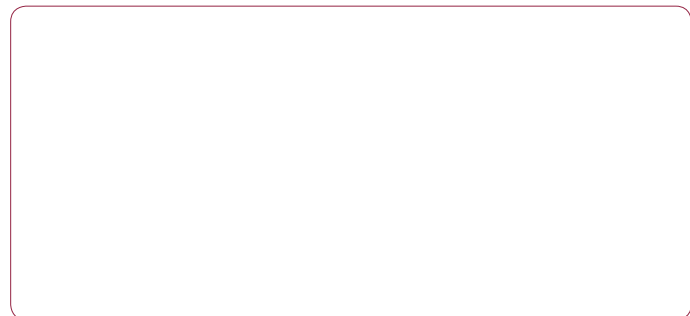


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