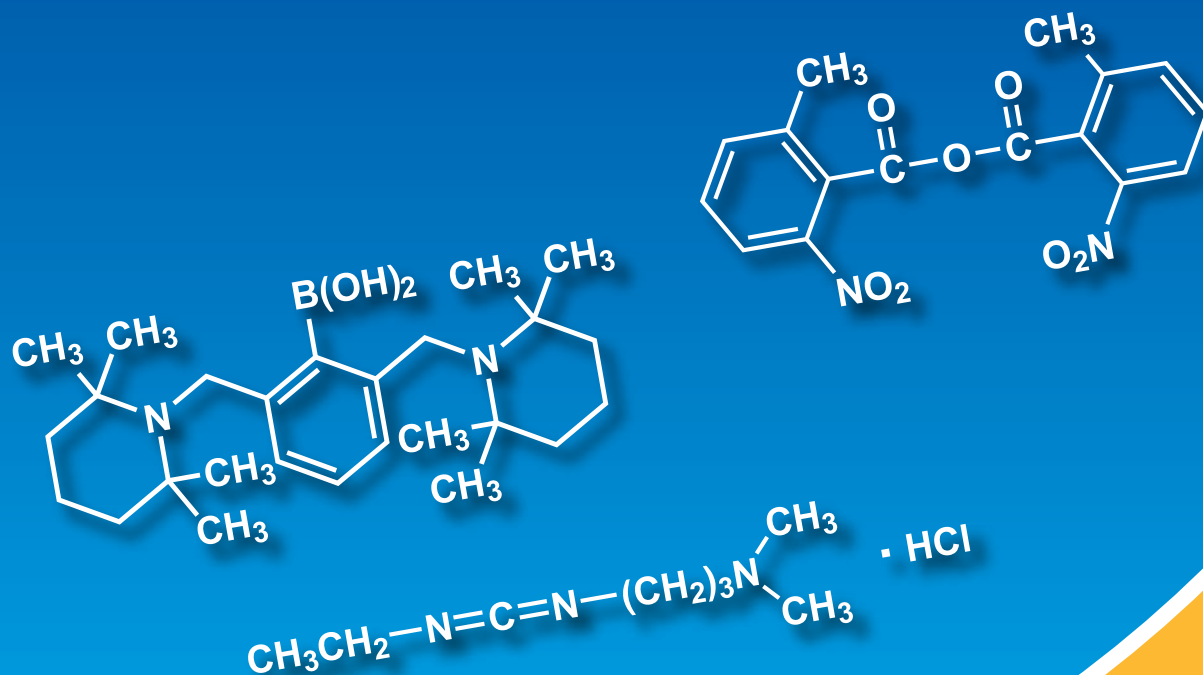


# Condensing Agents



Active Esters, Additives

Carbodiimides

Carbonyldiimidazoles

Phosgene Derivatives

Phosphonium Salts, Uronium Salts, Formamidinium Salts

Condensation Organocatalysts

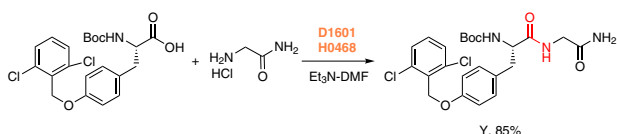
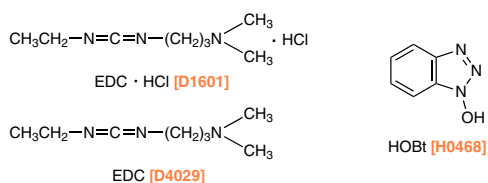
Others

# Condensing Agents

Esterification and amidation have been regarded as one of the most basic reactions in organic chemistry. Among them, esterification under an acidic conditions has been known for more than 100 years,<sup>1)</sup> the conditions of which being dependent on Le Chatelier's principle. To drive the reaction to completion, water is removed as the reaction progresses, usually via a Dean-Stark trap or a dehydrating reagent. However, this method is often ineffective when applied to thermally unstable materials. Milder conditions and condensing agents have been developed to surmount this problem. For amidation, the activation of a carboxylic acid is key with the amide bond formed through the nucleophilic addition of amines to an activated carboxylic acid. However, if the reactivity of the activated carboxy group is too high, epimerization at  $\alpha$ -position can occur. Reagents that do not impart epimerization have since been developed to avoid this potential issue. With significant research into esterification and amidation having been conducted for many years, many condensing agents which have both high reactivity and control of epimerization are readily available. Furthermore, many reviews of these methods and reagents have been reported.<sup>2)</sup> Applications and references for these varied methods are available on each of TCI's product pages.

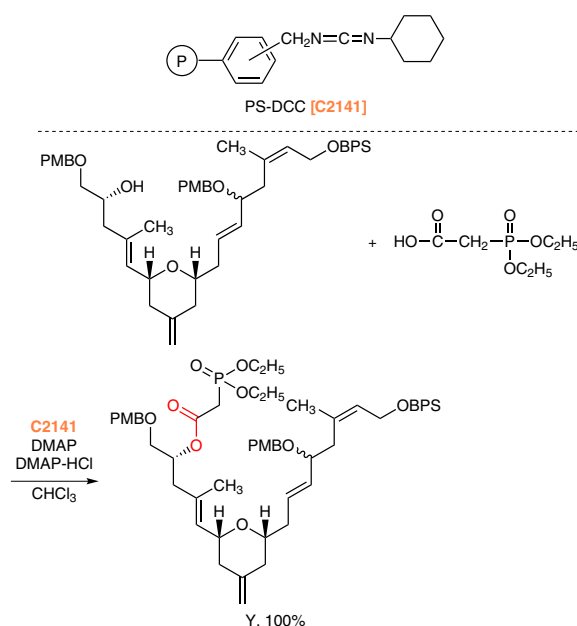
## ● EDC + HOBt

Since the first report of a condensation reaction utilizing *N,N'*-dicyclohexylcarbodiimide (DCC) [D0436] in 1950's,<sup>3)</sup> many carbodiimide reagents have been developed. Among them, 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide (EDC) [D1601], and [D4029] are favored as the byproducts are easily removed by partition. EDC can be used together with 1-hydroxybenzotriazole (HOBt)<sup>4)</sup> [H0468] which is one of the most used conditions for condensations.



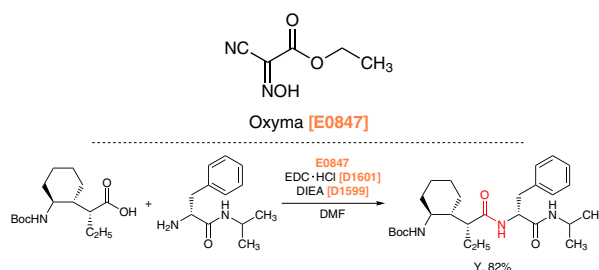
## ● PS-DCC

It often becomes troublesome to remove byproducts when applying to condensing agents. Removal of byproducts from condensation reactions is one of the more troublesome aspects of the reactions. Dicyclohexylurea, a byproduct from DCC, is notoriously difficult to remove. However, polymer supported PS-DCC [C2141] has the advantage of easily removal by simple filtration and is often employed in the total synthesis of natural products.<sup>5)</sup>



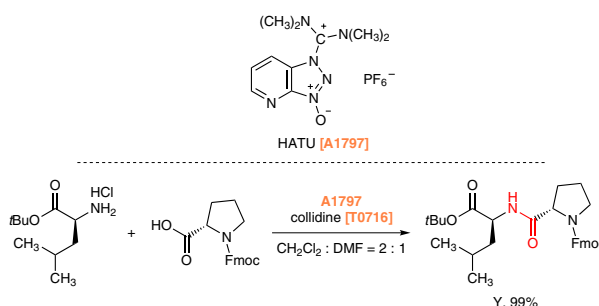
## ● Oxyma

1,2,3-Triazol derivatives are utilized in the synthesis of active esters and are frequently used with carbodiimides, but are potentially explosive if dried. The reagent oxyma [E0847] bears the same reactivity to that of triazoles with a minimized explosion risk.<sup>6-9)</sup>



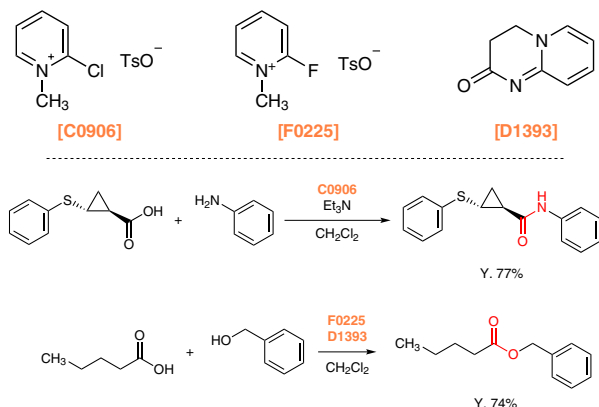
## ● HATU

Uronium salts represented by HATU [A1797] have been known as condensing agents with both high reactivity and suppressed epimerization.<sup>10,11)</sup>



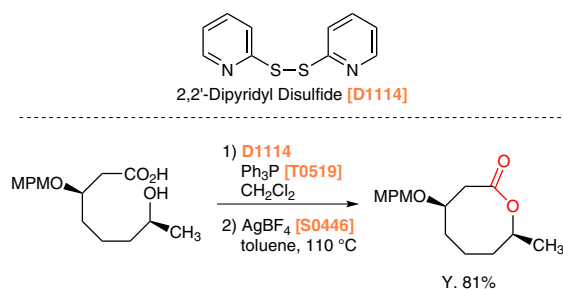
## Mukaiyama Condensing Agents

Mukaiyama *et al.* reported 2-chloro-1-methylpyridinium *p*-toluene-sulfonate [C0906] and 2-fluoro-1-methylpyridinium *p*-toluene-sulfonate [F0225] which were utilized in condensation reactions.<sup>12,13</sup> In this reaction, either conventional organic bases such as triethylamine or acid captor H [D1393] can be used as an acid sequesterant.



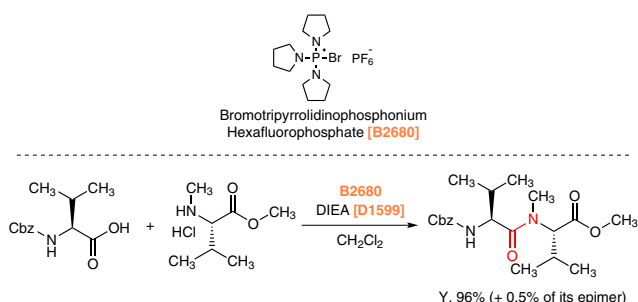
## Corey-Nicolaou macrolactonization

2,2'-Dipyridyl disulfide [D1114] is useful for the lactonization and is conducted under mild conditions. Corey and Nicolaou have reported this method in several total syntheses making use of this reagent.<sup>14,15</sup>



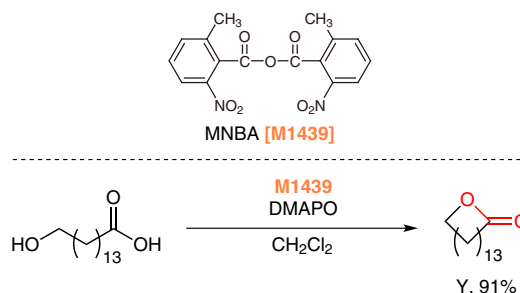
## Bromotripyrrolidinophosphonium Hexafluorophosphate

Phosphonium salts such as bromotripyrrolidinophosphonium hexafluorophosphate [B2680] also have utility in condensation reactions.<sup>16</sup> When using these salts, additives like HOBT are not necessary. Furthermore, the rate of epimerization is low and N-methyl amino acid derivatives, which are difficult to impart reactivity on, are applicable. In this way, these salts are anticipated to be used more frequently in further research.



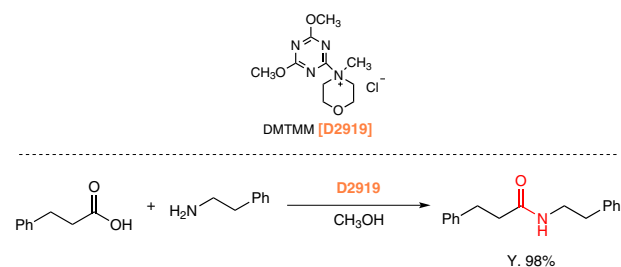
## Shiina Macrolactonization

Shiina *et al.* have reported that 2-methyl-6-nitrobenzoic anhydride (MNBA) [M1439] affords esters or amides in high yields from mostly equimolar carboxylic acid and alcohols or amines under basic conditions.<sup>17,18</sup> This method is also utilized in macrolactonizations.



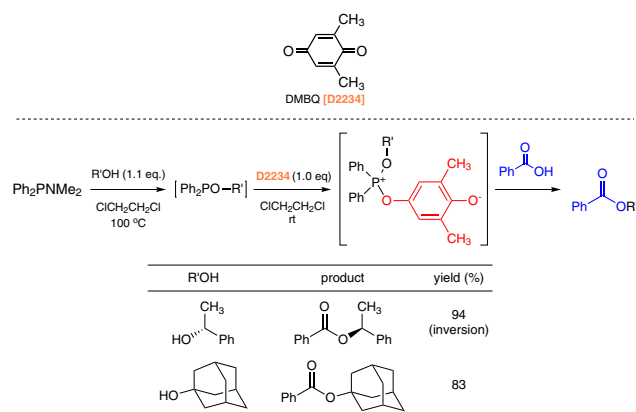
## DMTMM

Kunishima *et al.* have reported the utility of 4-(4,6-dimethoxy-1,3,5-triazin-2-yl)-4-methylmorpholinium chloride (DMTMM) [D2919] as a condensing reagent.<sup>19,20</sup> This reagent has some advantages: amidation proceeds selectively even in alcohol solvent and the byproducts are easy to remove. D2919 can be used as a powerful condensing reagent.<sup>21</sup>



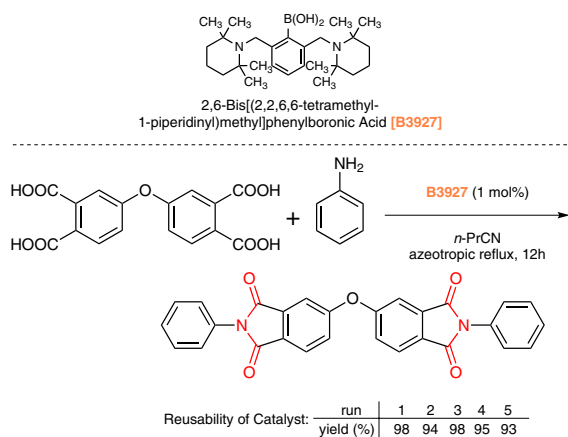
## Mukaiyama Redox Condensation

Mukaiyama *et al.* have reported a redox condensation reaction using dihydroquinone derivatives such as 2,6-dimethyl-1,4-benzoquinone (DMBQ) [D2234].<sup>22,23</sup> In this reaction, tertiary alcohols with high steric hindrance can react and afford products with stereoinversion. Furthermore, this reaction is even applicable to 1-adamantanol, the structure of which being highly resistant to stereoinversion.



## ● Organocatalysts for Condensation Reactions

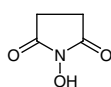
2,6-Bis[(2,2,6,6-tetramethyl-1-piperidinyl)methyl]phenylboronic acid **[B3927]** is a hybrid catalyst developed by Ishihara *et al.*, which has Lewis acid and Brønsted base moieties within the molecule. **B3927** catalyzes the condensation of dicarboxylic acids, such as phthalic acid, and amines to afford the corresponding imides in high yields under mild conditions. In addition, **B3927** is recyclable and retains its catalytic ability after five usages.<sup>24,25)</sup>



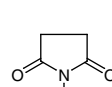
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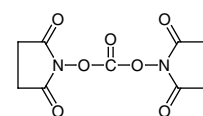
## Active Esters, Additives

**B0249** 25g


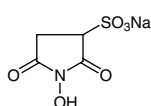
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[Coupling Reagent for Peptide]  
CAS RN: 6066-82-6

**H0623** 25g 100g 500g


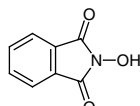
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**D1662** 5g 25g


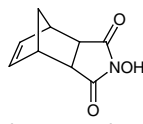
DSC  
CAS RN: 74124-79-1

**H1304** 200mg 1g


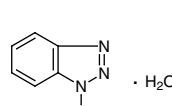
Sulfo-NHS  
CAS RN: 106627-54-7

**H0395** 25g 100g 500g


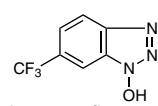
N-Hydroxyphthalimide  
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**H0528** 25g 250g


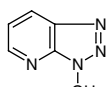
N-Hydroxy-5-norbornene-2,3-dicarboximide  
CAS RN: 21715-90-2

**H0468** 25g 200g


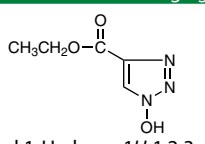
HOBT Monohydrate  
CAS RN: 80029-43-2

**H1454** 1g 5g


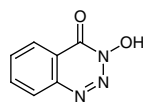
1-Hydroxy-6-(trifluoromethyl)-benzotriazole  
CAS RN: 26198-21-0

**T1673** 1g 5g 25g


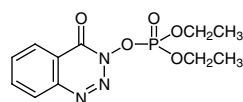
HOAt  
CAS RN: 39968-33-7

**E0901** 1g 5g


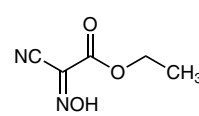
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**D2039** 10g 25g


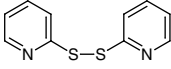
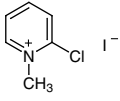
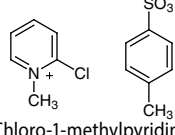

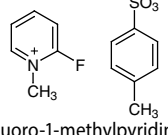
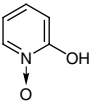
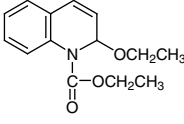
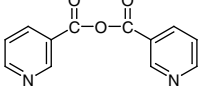
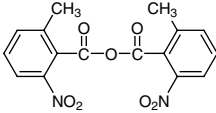
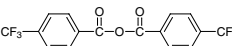
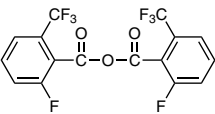
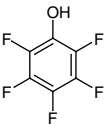
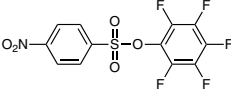
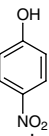
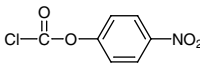
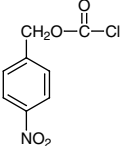
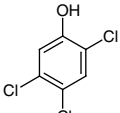
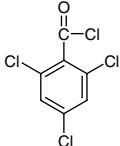
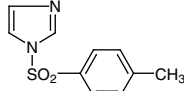
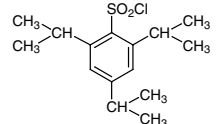
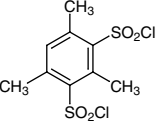
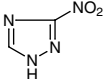
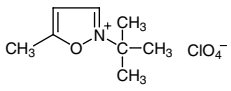
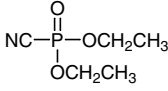
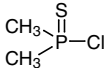
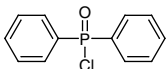
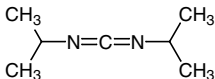
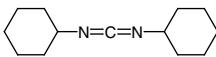
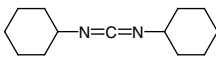
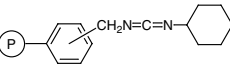
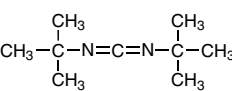
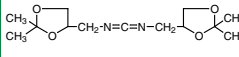
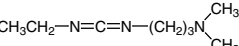
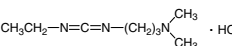
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CAS RN: 28230-32-2

**D3262** 5g


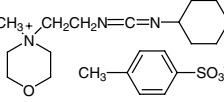
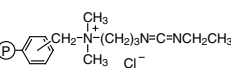
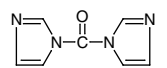
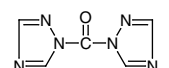
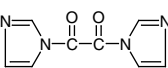
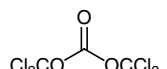
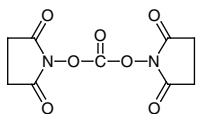
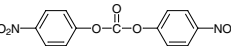
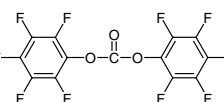
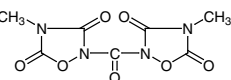
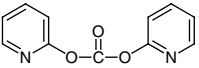

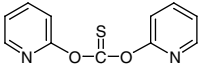
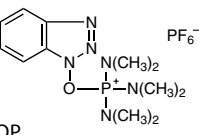
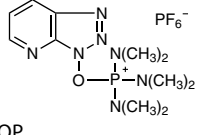
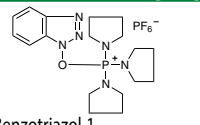
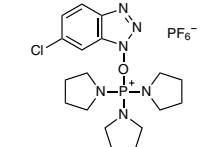
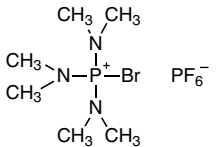
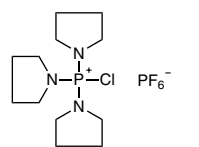
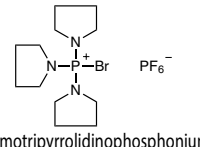
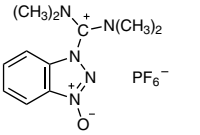
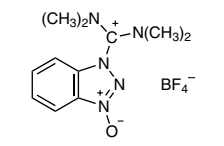
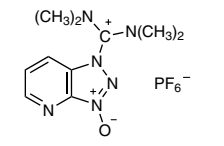
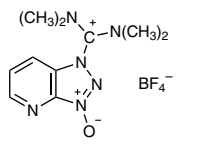
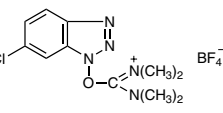
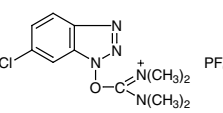
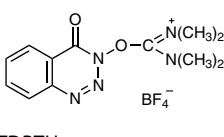
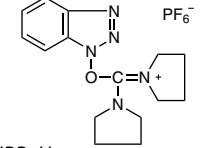
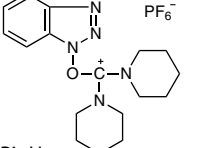
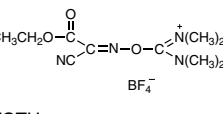
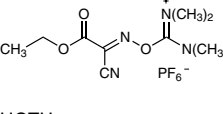
DEPBT  
CAS RN: 165534-43-0

**E0847** 25g 100g


Oxyma  
CAS RN: 3849-21-6

<b>D1114</b> 5g 25g 250g  2,2'-Dithiodipyridine CAS RN: 2127-03-9	<b>C0903</b> 25g  2-Chloro-1-methylpyridinium iodide CAS RN: 14338-32-0	<b>C0906</b> 25g  2-Chloro-1-methylpyridinium <i>p</i> -Toluenesulfonate CAS RN: 7403-46-5	<b>B1036</b> 5g 25g  2-Bromo-1-ethylpyridinium Tetrafluoroborate CAS RN: 878-23-9	<b>F0225</b> 5g 25g  2-Fluoro-1-methylpyridinium <i>p</i> -Toluenesulfonate CAS RN: 58086-67-2
<b>H0672</b> 25g  2-Hydroxypyridine <i>N</i> -Oxide CAS RN: 13161-30-3	<b>E0363</b> 25g  EEDQ CAS RN: 16357-59-8	<b>P1768</b> 1g 5g  Nicotinic Anhydride CAS RN: 16837-38-0	<b>M1439</b> 1g 5g 25g  MNBA CAS RN: 434935-69-0	<b>T1593</b> 10g  TFBA CAS RN: 25753-16-6
<b>F1184</b> 1g  FTBBA CAS RN: 2118332-08-2	<b>P0919</b> 10g 25g  Pentafluorophenol CAS RN: 771-61-9	<b>P2231</b> 1g 5g  4-Nitrobenzenesulfonate CAS RN: 244633-31-6	<b>N0220</b> 25g 100g 500g  4-Nitrophenol CAS RN: 100-02-7	<b>C1400</b> 25g 250g  4-Nitrophenyl Chloroformate CAS RN: 7693-46-1
<b>C1077</b> 25g  4-Nitrobenzyl Chloroformate CAS RN: 4457-32-3	<b>T0389</b> 25g 500g  2,4,5-Trichlorophenol CAS RN: 95-95-4	<b>T1413</b> 5g 25g  2,4,6-Trichlorobenzoyl Chloride CAS RN: 4136-95-2	<b>T1985</b> 5g 25g  1-Tosylimidazole CAS RN: 2232-08-8	<b>T0459</b> 25g 500g  2,4,6-Triisopropylbenzenesulfonyl Chloride CAS RN: 6553-96-4
<b>M1186</b> 5g 25g  2,4-Mesitylenedisulfonyl Dichloride CAS RN: 68985-08-0	<b>N0477</b> 1g 5g  3-Nitro-1,2,4-triazole CAS RN: 24807-55-4	<b>B0832</b> 1g 5g  Woodward's Reagent L CAS RN: 10513-45-8	<b>C1242</b> 5g 25g  Diethyl Cyanophosphonate CAS RN: 2942-58-7	<b>D2159</b> 1g 5g  Dimethylthiophosphinoyl Chloride CAS RN: 993-12-4
<b>C1415</b> 5g 10g 25g  Diphenylphosphinic Chloride CAS RN: 1499-21-4				
<h2>Carbodiimides</h2>				
<b>D0254</b> 25g 250g  DIC CAS RN: 693-13-0	<b>D0436</b> 25g 400g  DCC CAS RN: 538-75-0	<b>D0437</b> 100mL  DCC (25% in Pyridine, ca. 1.2mol/L) CAS RN: 538-75-0		
<b>C2141</b> 5g  PS-DCC cross-linked with 1% DVB (50-100mesh) (1.4-1.6mmol/g)	<b>D5347</b> 5mL 25mL  <i>N,N'</i> -Di- <i>tert</i> -butylcarbodiimide CAS RN: 691-24-7	<b>B2771</b> 1g  BDDC CAS RN: 159390-26-8	<b>D4029</b> 5g 25g 100g  EDC CAS RN: 1892-57-5	<b>D1601</b> 5g 25g 100g 250g  EDC·HCl CAS RN: 25952-53-8

## Condensing Agents

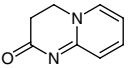
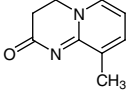

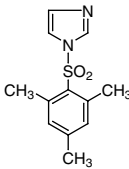
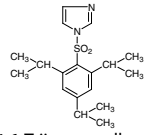
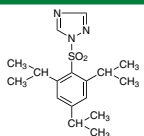
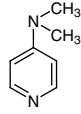
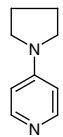
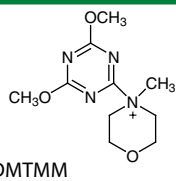
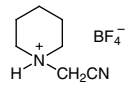
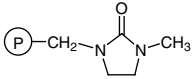
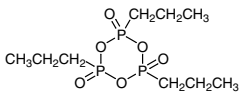
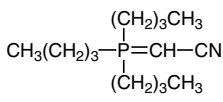
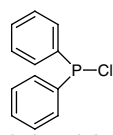
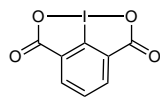
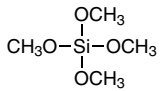
<p><b>C0793</b> 5g 25g</p>  <p>CMC CAS RN: 2491-17-0</p>	<p><b>D3525</b> 5g</p>  <p>EDC Resin cross-linked with 1% DVB (50-100mesh) (1.0-1.3mmol/g)</p>			
<h1>Carbonyldiimidazoles</h1>		<p><b>C0119</b> 5g 25g 250g</p>  <p>CDI CAS RN: 530-62-1</p>	<p><b>C2325</b> 5g 25g</p>  <p>CDT CAS RN: 41864-22-6</p>	<p><b>O0200</b> 1g 5g</p>  <p>1,1'-Oxalyldiimidazole CAS RN: 18637-83-7</p>
<h1>Phosgene Derivatives</h1>		<p><b>T1467</b> 25g 250g</p>  <p>Triphosgene CAS RN: 32315-10-9</p>	<p><b>D1662</b> 5g 25g</p>  <p>DSC CAS RN: 74124-79-1</p>	<p><b>C1481</b> 5g 25g</p>  <p>Bis(4-nitrophenyl) Carbonate CAS RN: 5070-13-3</p>
<p><b>B3604</b> 5g</p>  <p>Bis(pentafluorophenyl) Carbonate CAS RN: 59483-84-0</p>	<p><b>C1362</b> 5g</p>  <p>2,2'-Carbonylbis(3,5-dioxo-4-methyl-1,2,4-oxadiazolidine) CAS RN: 115491-90-2</p>	<p><b>C1407</b> 1g 5g</p>  <p>Di-2-pyridyl Carbonate CAS RN: 1659-31-0</p>	<p><b>T1320</b> 25g 100g</p>  <p>Thiophosgene CAS RN: 463-71-8</p>	<p><b>T1906</b> 1g</p>  <p>O,O'-Di-2-pyridyl Thiocarbonate CAS RN: 96989-50-3</p>
<h1>Phosponium Salts, Uronium Salts, Formamidinium Salts</h1>		<p><b>B1651</b> 5g 25g 100g</p>  <p>BOP CAS RN: 56602-33-6</p>	<p><b>A2782</b> 1g 5g</p>  <p>AOP CAS RN: 156311-85-2</p>	<p><b>B1774</b> 5g 25g</p>  <p>1H-Benzotriazol-1-yloxytripyrrolidinophosponium Hexafluorophosphate CAS RN: 128625-52-5</p>
<p><b>C3461</b> 5g 25g</p>  <p>TPTDP CAS RN: 893413-42-8</p>	<p><b>B3838</b> 1g 5g</p>  <p>BroP CAS RN: 50296-37-2</p>	<p><b>C2551</b> 5g 25g</p>  <p>PyClop CAS RN: 133894-48-1</p>	<p><b>B2680</b> 5g 25g</p>  <p>Bromotripyrrolidinophosponium Hexafluorophosphate CAS RN: 132705-51-2</p>	<p><b>B1657</b> 5g 25g 100g</p>  <p>HBTU CAS RN: 94790-37-1</p>
<p><b>B1658</b> 5g 25g</p>  <p>TBTU CAS RN: 125700-67-6</p>	<p><b>A1797</b> 5g 25g</p>  <p>HATU CAS RN: 148893-10-1</p>	<p><b>A1861</b> 1g 5g</p>  <p>TATU CAS RN: 873798-09-5</p>	<p><b>C1926</b> 5g 25g</p>  <p>TCTU CAS RN: 330641-16-2</p>	<p><b>C1988</b> 1g 5g</p>  <p>HCTU CAS RN: 330645-87-9</p>
<p><b>D3263</b> 5g 25g</p>  <p>TDBTU CAS RN: 125700-69-8</p>	<p><b>B4805</b> 1g 5g</p>  <p>HBPyU CAS RN: 105379-24-6</p>	<p><b>B3816</b> 1g 5g</p>  <p>HBPIP CAS RN: 206752-41-2</p>	<p><b>E0916</b> 1g 5g</p>  <p>TOTU CAS RN: 136849-72-4</p>	<p><b>E1306</b> 1g 5g</p>  <p>HOTU CAS RN: 333717-40-1</p>

<b>O0390</b> 1g 5g  TPTU CAS RN: 125700-71-2	<b>N0634</b> 5g 25g  TNTU CAS RN: 125700-73-4	<b>T2224</b> 1g 5g  TSTU CAS RN: 105832-38-0	<b>T2929</b> 5g 25g  HSTU CAS RN: 265651-18-1	<b>B3817</b> 1g 5g  HSPyU CAS RN: 207683-26-9
<b>T3569</b> 5g 25g  TOTT CAS RN: 255825-38-8	<b>T2821</b> 5g  HOTT CAS RN: 212333-72-7	<b>F0726</b> 1g 5g  TFFH CAS RN: 164298-23-1	<b>C1957</b> 1g 5g  TCFH CAS RN: 94790-35-9	<b>C1375</b> 5g  TPyClU CAS RN: 115007-14-2
<b>C1379</b> 5g 25g  PyClU CAS RN: 135540-11-3	<b>C1408</b> 5g 25g  DMC CAS RN: 37091-73-9	<b>C1639</b> 25g  DMC (ca. 25% in Dichloromethane) CAS RN: 37091-73-9	<b>C1651</b> 5g 25g  ClP CAS RN: 101385-69-7	<b>C3444</b> 1g 5g  ClB CAS RN: 153433-26-2
<h2>Condensation Organocatalysts</h2>				
<b>D3683</b> 1g 5g 25g  DPAT CAS RN: 164411-06-7				
<b>T1122</b> 25g  CPTS CAS RN: 59229-09-3				
<b>P0941</b> 5g 25g  Pyridinium 3-Nitrobenzenesulfonate CAS RN: 84752-61-4				
<b>P1626</b> 1g 5g 25g  PFPAT CAS RN: 912823-79-1	<b>D3293</b> 1g 5g  Dimesitylammonium Pentafluorobenzenesulfonate CAS RN: 850629-65-1	<b>B2291</b> 100mg 1g  $\alpha, \alpha$ -Bis(trifluoromethanesulfonyl)- 2,3,4,5,6-pentafluorotoluene CAS RN: 405074-81-9	<b>B2292</b> 100mg  Bis(trifluoromethanesulfonyl)methyltetrafluorophenyl Polystyrene Resin cross-linked with 2% DVB (200- 400mesh) (0.9-1.2mmol/g)	
<b>B1886</b> 1g 5g 25g  3,5-Bis(trifluoromethyl)- phenylboronic Acid CAS RN: 73852-19-4	<b>B3022</b> 1g 5g  2,4-Bis(trifluoromethyl)- phenylboronic Acid CAS RN: 153254-09-2	<b>T1929</b> 1g 5g  2,4,6-Tris(3,4,5- trifluorophenyl)boroxin CAS RN: 223440-94-6	<b>B3927</b> 200mg 1g  2,6-Bis((2,2,6,6-tetramethyl- 1-piperidiny)methyl)- phenylboronic Acid CAS RN: 1243264-54-1	<b>T2908</b> 1g  2-((2,2,6,6-Tetramethyl-1-piperidiny)- methyl)phenylboronic Acid CAS RN: 815581-79-4
<b>D3962</b> 1g 5g  1,4-Dimethyl- 1,2,4-triazolium Iodide CAS RN: 120317-69-3	<b>D3982</b> 100mg  6,7-Dihydro-2-mesityl- 5H-pyrrolo[2,1-c]-1,2,4- triazolium Perchlorate CAS RN: 1334529-08-6	<b>B0887</b> 25g 500g  1,4-Benzoquinone CAS RN: 106-51-4		
<b>D2234</b> 1g 5g 25g  DMBQ CAS RN: 527-61-7			<b>D2256</b> 5g 25g  2,6-Di-tert-butyl-p-quinone CAS RN: 719-22-2	

## Others



## Condensing Agents

<b>D1393</b> 5g 25g  Acid Captor H CAS RN: 5439-14-5	<b>M0670</b> 25g  Acid Captor 9M CAS RN: 61751-44-8	<b>T0340</b> 25g 100g 500g  1,2,4-Triazole CAS RN: 288-88-0	<b>M0625</b> 1g  MSI CAS RN: 50257-39-1	<b>T1410</b> 5g 25g  1-(2,4,6-Triisopropylbenzenesulfonyl)imidazole CAS RN: 50257-40-4
<b>T2951</b> 1g 5g  1-(2,4,6-Triisopropylbenzenesulfonyl)-1,2,4-triazole CAS RN: 54230-60-3	<b>D1450</b> 25g 100g 500g  DMAP CAS RN: 1122-58-3	<b>P0939</b> 5g 25g  4-Pyrrolidinopyridine CAS RN: 2456-81-7	<b>D2919</b> 5g 25g  DMTMM CAS RN: 3945-69-5	<b>C2421</b> 5g  1-(Cyanomethyl)piperidinium Tetrafluoroborate CAS RN: 434937-12-9
<b>M1452</b> 1g  3-Methyl-2-oxoimidazolidin-1-ylmethyl Polystyrene Resin cross-linked with 1% DVB	<b>P1320</b> 25g  Propylphosphonic Acid Anhydride (Cyclic Trimer) (48% in <i>N,N</i> -Dimethylformamide, ca. 1.6mol/L) CAS RN: 68957-94-8	<b>C1500</b> 1g 5g 25g  Tsunoda Reagent CAS RN: 157141-27-0	<b>C0597</b> 25g 100g 500g  Chlorodiphenylphosphine CAS RN: 1079-66-9	<b>I0865</b> 1g  Iodosodilactone CAS RN: 2902-68-3
<b>T0588</b> 25g 100g 500g  TMOS CAS RN: 681-84-5				

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