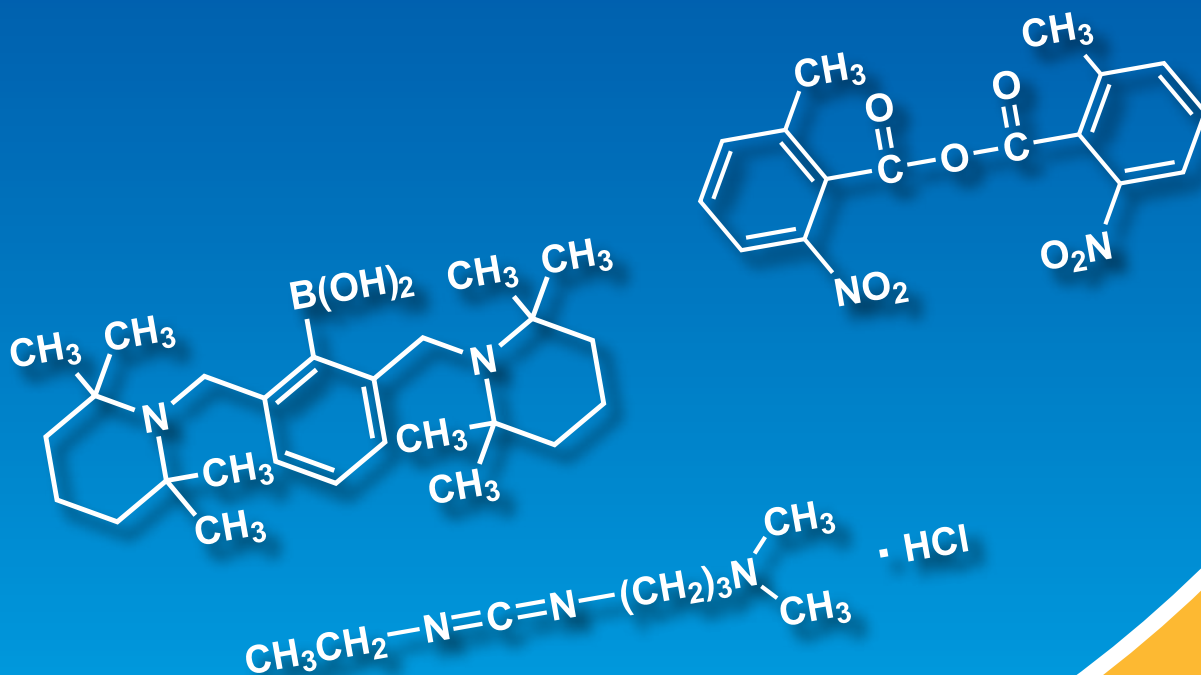


Condensing Agents



Active Esters, Additives

Carbodiimides

Carbonyldiimidazoles

Phosgene Derivatives

Phosphonium Salts, Uronium Salts, Formamidinium Salts

Condensation Organocatalysts

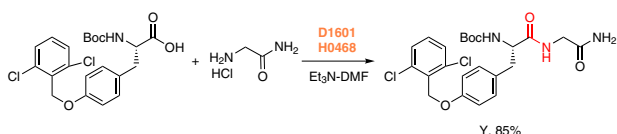
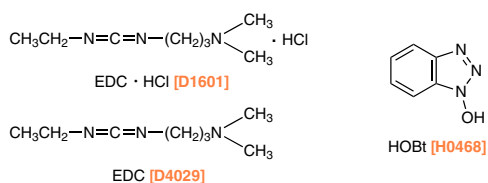
Others

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,¹⁾ 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 α -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.²⁾ Applications and references for these varied methods are available on each of TCI's product pages.

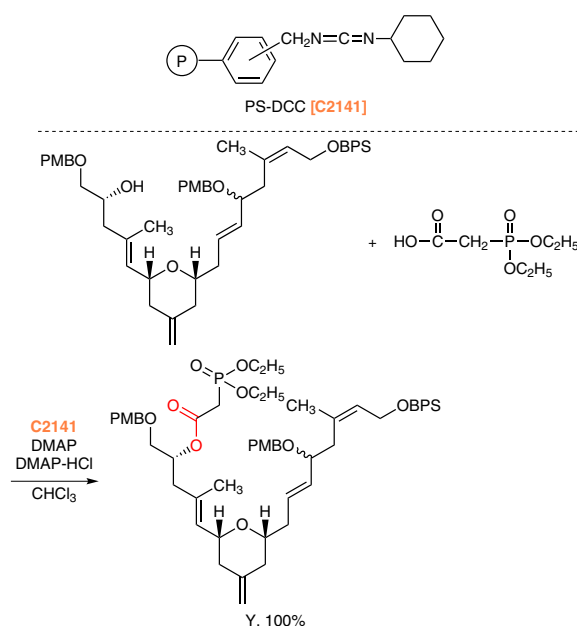
● EDC + HOBt

Since the first report of a condensation reaction utilizing *N,N'*-dicyclohexylcarbodiimide (DCC) [D0436] in 1950's,³⁾ 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)⁴⁾ [H0468] which is one of the most used conditions for condensations.



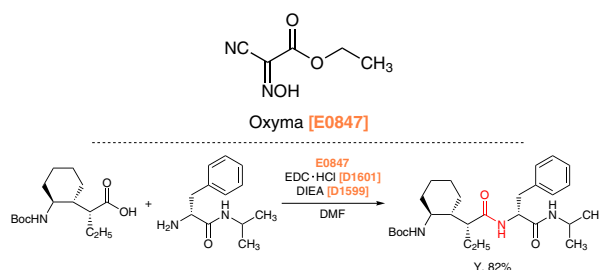
● PS-DCC

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.⁵⁾



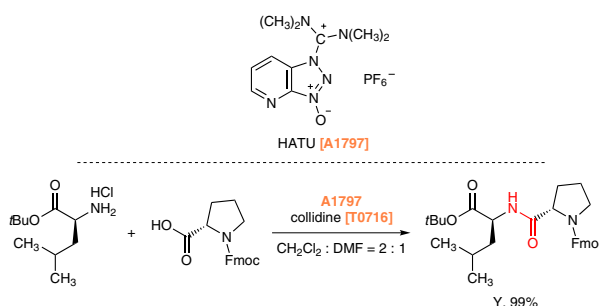
● Oxyma

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.⁶⁻⁹⁾



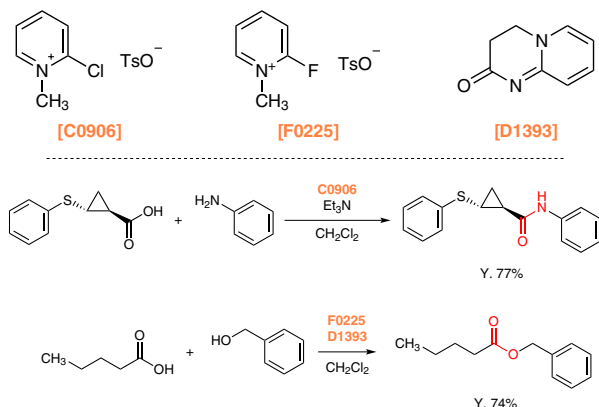
● HATU

Uronium salts represented by HATU [A1797] have been known as condensing agents with both high reactivity and suppressed epimerization.^{10,11)}



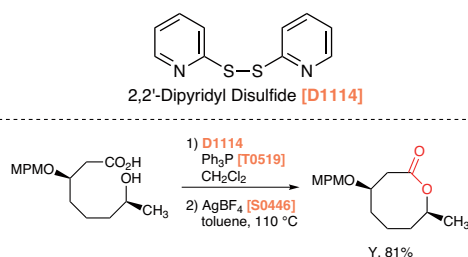
Mukaiyama Condensing Agents

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



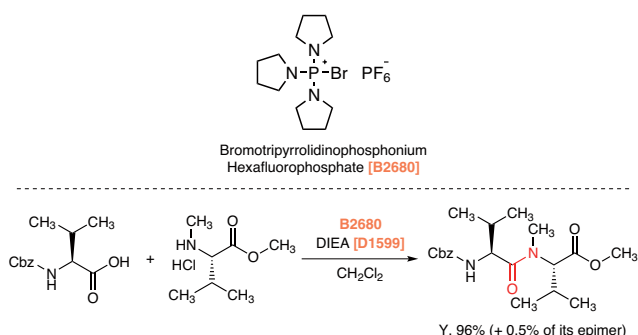
Corey-Nicolaou macrolactonization

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.^{14,15}



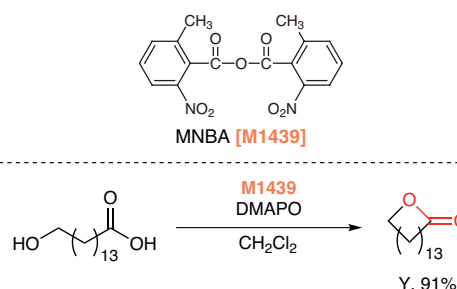
Bromotripyrrolidinophosphonium Hexafluorophosphate

Phosphonium salts such as bromotripyrrolidinophosphonium hexafluorophosphate [B2680] also have utility in condensation reactions.¹⁶ 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.



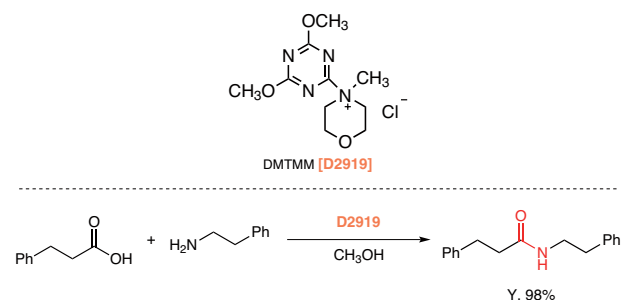
Shiina Macrolactonization

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.^{17,18} This method is also utilized in macrolactonizations.



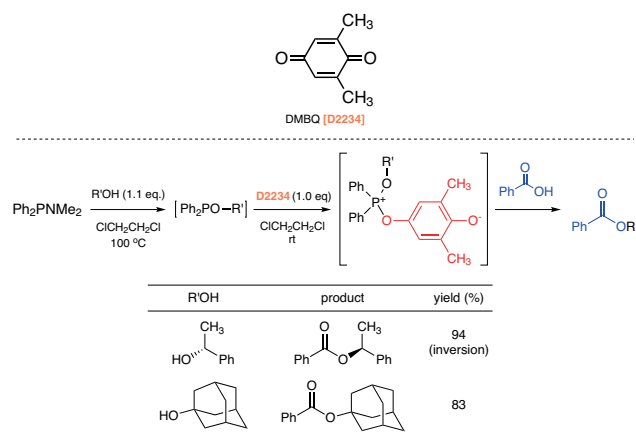
DMTMM

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.^{19,20} 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.²¹



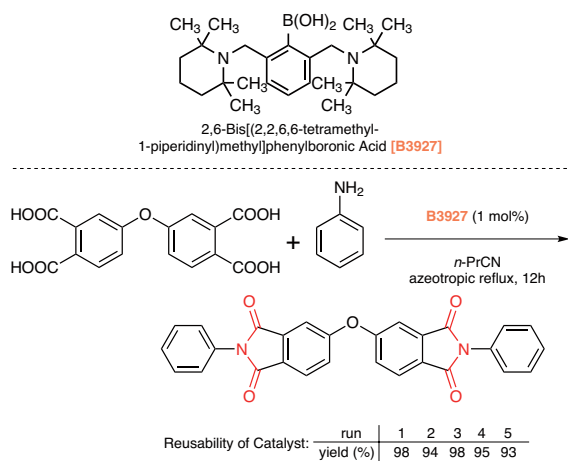
Mukaiyama Redox Condensation

Mukaiyama *et al.* have reported a redox condensation reaction using dihydroquinone derivatives such as 2,6-dimethyl-1,4-benzoquinone (DMBQ) [D2234].^{22,23} 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.^{24,25}

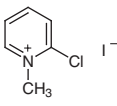
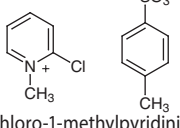

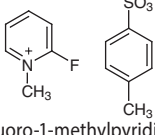

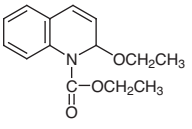
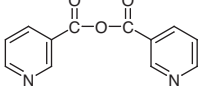
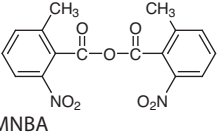
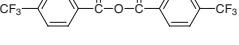
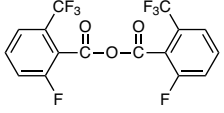
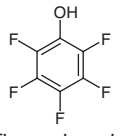
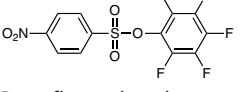
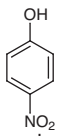
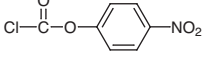
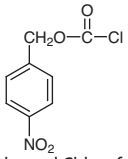
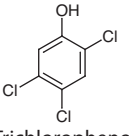
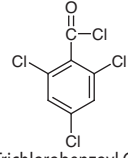
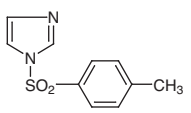
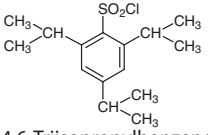
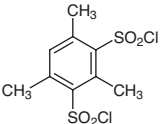
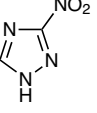
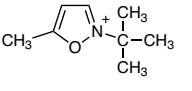
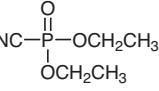
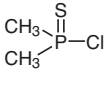
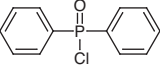
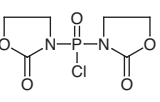
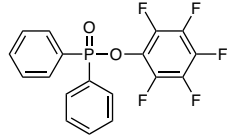
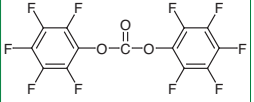
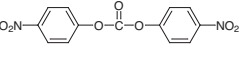
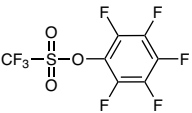
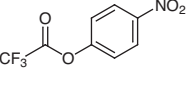
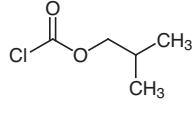
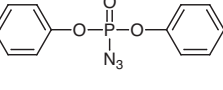
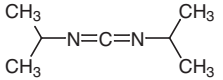
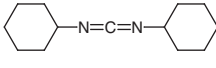
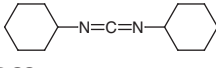


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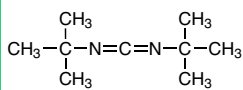
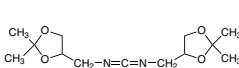
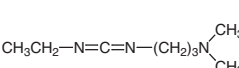
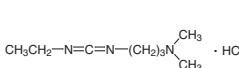
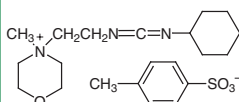
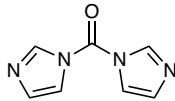
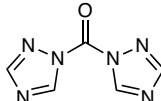
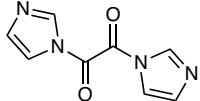
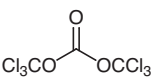
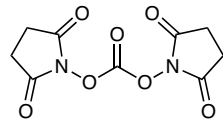
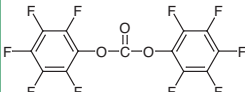
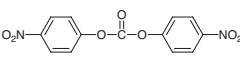
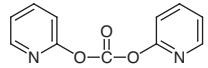

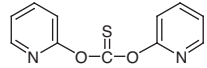
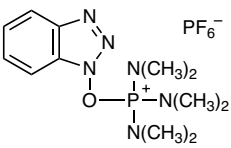
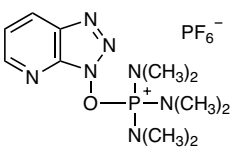
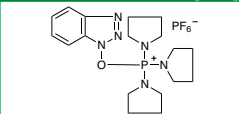
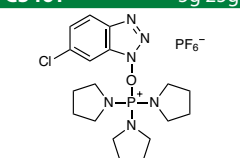
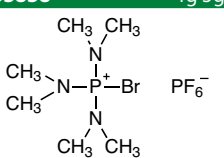
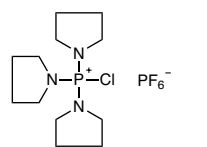
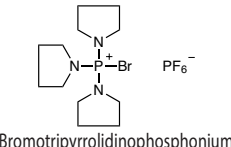
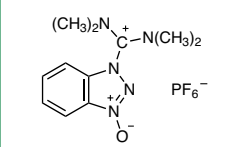
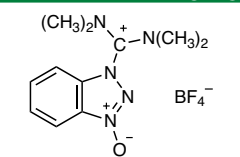
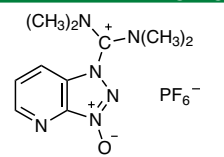
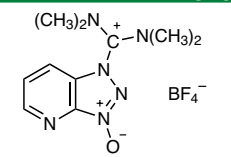
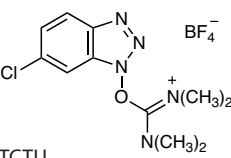
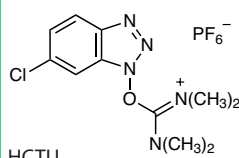
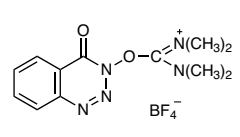
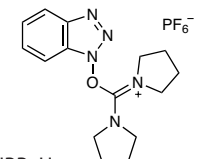
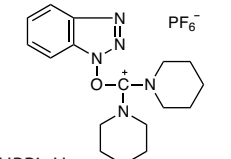
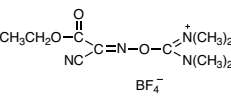
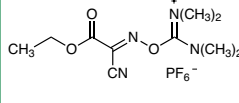
Active Esters, Additives

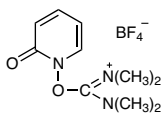
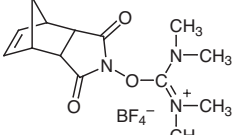
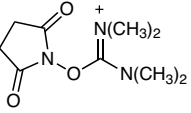
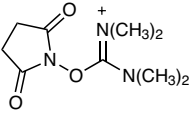
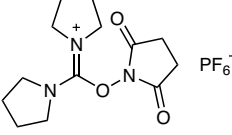
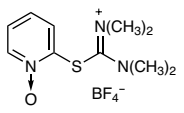
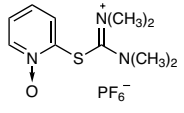
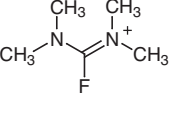
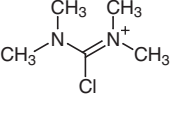
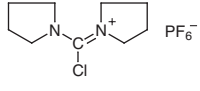
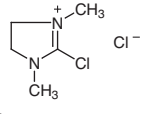
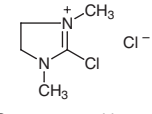
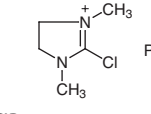
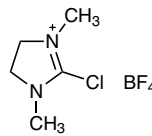
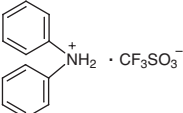
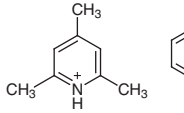
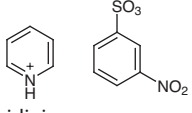
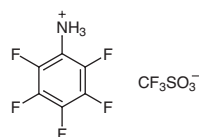
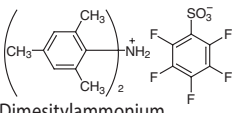
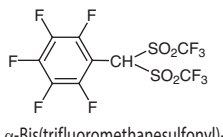
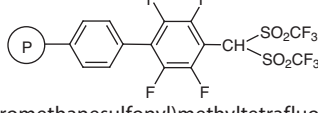
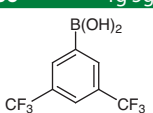
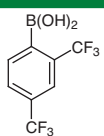
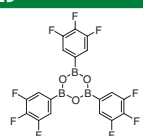
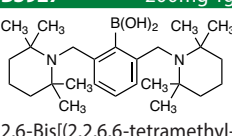
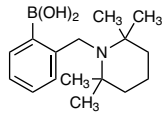
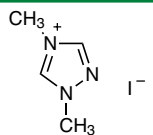
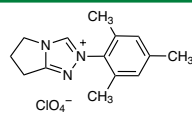
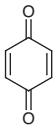
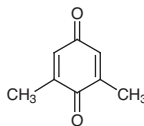
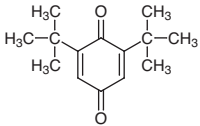
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Sulfo-NHS CAS RN: 106627-54-7	N-Hydroxyphthalimide CAS RN: 524-38-9	N-Hydroxy-5-norbornene-2,3-dicarboximide CAS RN: 21715-90-2	HOBt Monohydrate CAS RN: 80029-43-2	1-Hydroxy-6-(trifluoromethyl)-benzotriazole CAS RN: 26198-21-0
E0901 1g 5g	D2039 10g 25g	D3262 5g	E0847 25g 100g	D1114 5g 25g 250g
Ethyl 1-Hydroxy-1H-1,2,3-triazole-4-carboxylate CAS RN: 137156-41-3	3-Hydroxy-4-ketobenzotriazine CAS RN: 28230-32-2	DEPBT CAS RN: 165534-43-0	Oxyma CAS RN: 3849-21-6	2,2'-Dithiodipyridine CAS RN: 2127-03-9

C0903 25g  2-Chloro-1-methylpyridinium Iodide CAS RN: 14338-32-0	C0906 25g  2-Chloro-1-methylpyridinium p-Toluenesulfonate CAS RN: 7403-46-5	B1036 5g 25g  2-Bromo-1-ethylpyridinium Tetrafluoroborate CAS RN: 878-23-9	F0225 5g 25g  2-Fluoro-1-methylpyridinium p-Toluenesulfonate CAS RN: 58086-67-2	H0672 25g  2-Hydroxypyridine N-Oxide CAS RN: 13161-30-3	
E0363 25g  EEDQ CAS RN: 16357-59-8	P1768 1g 5g  Nicotinic Anhydride CAS RN: 16837-38-0	M1439 1g 5g 25g  MNBA CAS RN: 434935-69-0	T1593 10g  TFBA CAS RN: 25753-16-6	F1184 1g  FTFBA CAS RN: 2118332-08-2	
P0919 10g 25g  Pentafluorophenol CAS RN: 771-61-9	P2231 1g 5g  Pentafluorophenyl 4-Nitrobenzenesulfonate CAS RN: 244633-31-6	N0220 25g 100g 500g  4-Nitrophenol CAS RN: 100-02-7	C1400 25g 250g  4-Nitrophenyl Chloroformate CAS RN: 7693-46-1	C1077 25g  4-Nitrobenzyl Chloroformate CAS RN: 4457-32-3	
T0389 25g 500g  2,4,5-Trichlorophenol CAS RN: 95-95-4	T1413 5g 25g  2,4,6-Trichlorobenzoyl Chloride CAS RN: 4136-95-2	T1985 5g 25g  1-Tosylimidazole CAS RN: 2232-08-8	T0459 25g 500g  2,4,6-Triisopropylbenzenesulfonyl Chloride CAS RN: 6553-96-4	M1186 5g 25g  2,4-Mesitylenedisulfonyl Dichloride CAS RN: 68985-08-0	
N0477 1g 5g  3-Nitro-1,2,4-triazole CAS RN: 24807-55-4	B0832 1g 5g  Woodward's Reagent L CAS RN: 10513-45-8	C1242 5g 25g  Diethyl Cyanophosphonate CAS RN: 2942-58-7	D2159 1g 5g  Dimethylthiophosphinoyl Chloride CAS RN: 993-12-4	C1415 5g 25g  Diphenylphosphinic Chloride CAS RN: 1499-21-4	
B1213 5g 25g  BOP-Cl CAS RN: 68641-49-6	P2726 1g 5g  FDPP CAS RN: 138687-69-1	B3604 5g  Bis(pentafluorophenyl) Carbonate CAS RN: 59483-84-0	C1481 5g 25g  Bis(4-nitrophenyl) Carbonate CAS RN: 5070-13-3	P2188 200mg 1g  Pentafluorophenyl Triflate CAS RN: 60129-85-3	
T0681 5g 25g  4-Nitrophenyl Trifluoroacetate CAS RN: 658-78-6	C0178 25g 100g 500g  IBCF CAS RN: 543-27-1	D1672 5g 25g 250g  DPPA CAS RN: 26386-88-9	D0254 25g 250g  DIC CAS RN: 693-13-0	D0436 25g 400g  DCC CAS RN: 538-75-0	D0437 100mL  DCC (25% in Pyridine, ca. 1.2mol/L) CAS RN: 538-75-0

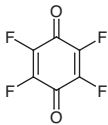
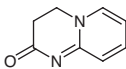
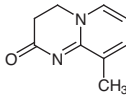


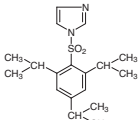
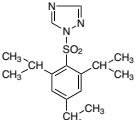
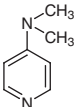
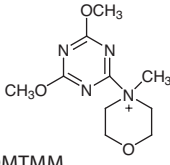
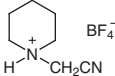
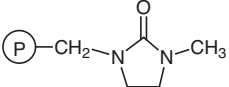
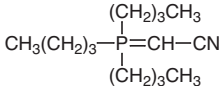
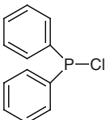
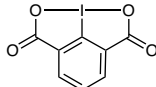
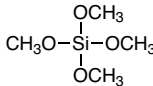
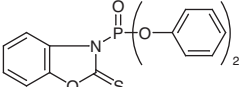
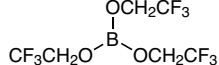
Carbodiimides

Condensing Agents

D5347 5mL 25mL  <i>N,N'</i> -Di- <i>tert</i> -butylcarbodiimide CAS RN: 691-24-7	B2771 1g  BDDC CAS RN: 159390-26-8	D4029 5g 25g 100g  EDC CAS RN: 1892-57-5	D1601 5g 25g 100g 250g  EDC·HCl CAS RN: 25952-53-8	C0793 5g 25g  CMC CAS RN: 2491-17-0
<h3>Carbonyldiimidazoles</h3>				
C0119 5g 25g 250g  CDI CAS RN: 530-62-1	C2325 5g 25g  CDT CAS RN: 41864-22-6	O0200 1g 5g  1,1'-Oxalyldiimidazole CAS RN: 18637-83-7		
<h3>Phosgene Derivatives</h3>				
T1467 25g 250g  Triphosgene CAS RN: 32315-10-9	D1662 5g 25g  DSC CAS RN: 74124-79-1	B3604 5g  Bis(pentafluorophenyl) Carbonate CAS RN: 59483-84-0		
C1481 5g 25g  Bis(4-nitrophenyl) Carbonate CAS RN: 5070-13-3	C1407 1g 5g  Di-2-pyridyl Carbonate CAS RN: 1659-31-0	T1320 25g 100g  Thiophosgene CAS RN: 463-71-8	T1906 1g  O,O'-Di-2-pyridyl Thiocarbonate CAS RN: 96989-50-3	
<h3>Phosponium Salts, Uronium Salts, Formamidinium Salts</h3>				
B1651 5g 25g 100g  BOP CAS RN: 56602-33-6	A2782 1g 5g  AOP CAS RN: 156311-85-2	B1774 5g 25g  1 <i>H</i> -Benzotriazol-1-ylxytripyrrolidinophosponium Hexafluorophosphate CAS RN: 128625-52-5		
C3461 5g 25g  TPTDP CAS RN: 893413-42-8	B3838 1g 5g  BroP CAS RN: 50296-37-2	C2551 5g 25g  PyClop CAS RN: 133894-48-1	B2680 5g 25g  Bromotripyrrolidinophosponium Hexafluorophosphate CAS RN: 132705-51-2	B1657 5g 25g 100g  HBTU CAS RN: 94790-37-1
B1658 5g 25g  TBTU CAS RN: 125700-67-6	A1797 5g 25g  HATU CAS RN: 148893-10-1	A1861 1g 5g  TATU CAS RN: 873798-09-5	C1926 5g 25g  TCTU CAS RN: 330641-16-2	C1988 1g 5g  HCTU CAS RN: 330645-87-9
D3263 5g 25g  TDBTU CAS RN: 125700-69-8	B4805 1g 5g  HBPpyU CAS RN: 105379-24-6	B3816 1g 5g  HBPipU CAS RN: 206752-41-2	E0916 1g 5g  TOTU CAS RN: 136849-72-4	E1306 1g 5g  HOTU CAS RN: 333717-40-1

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

Condensing Agents

T0790 1g 5g  Fluoranil CAS RN: 527-21-9	D1393 5g 25g  Acid Captor H CAS RN: 5439-14-5	M0670 25g  Acid Captor 9M CAS RN: 61751-44-8	T0340 25g 100g 500g  1,2,4-Triazole CAS RN: 288-88-0	T1017 5g 25g  1H-Tetrazole CAS RN: 288-94-8
T1410 5g 25g  1-(2,4,6-Triisopropylbenzenesulfonyl)imidazole CAS RN: 50257-40-4	T2951 1g 5g  1-(2,4,6-Triisopropylbenzenesulfonyl)-1,2,4-triazole CAS RN: 54230-60-3	D1450 25g 100g 500g  DMAP CAS RN: 1122-58-3	D2919 5g 25g  DMTMM CAS RN: 3945-69-5	C2421 5g  1-(Cyanomethyl)piperidinium Tetrafluoroborate CAS RN: 434937-12-9
M1452 1g  3-Methyl-2-oxoimidazolidin-1-ylmethyl Polystyrene Resin cross-linked with 1% DVB	C1500 1g 5g 25g  Tsunoda Reagent CAS RN: 157141-27-0	C0597 25g 100g 500g  Chlorodiphenylphosphine CAS RN: 1079-66-9	I0865 1g  Iodosodilactone CAS RN: 2902-68-3	T0588 25g 100g 500g  TMOS CAS RN: 681-84-5
D2038 5g 25g  DBOP CAS RN: 111160-56-6	T3010 1g  Tris(2,2,2-trifluoroethyl) Borate CAS RN: 659-18-7			

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