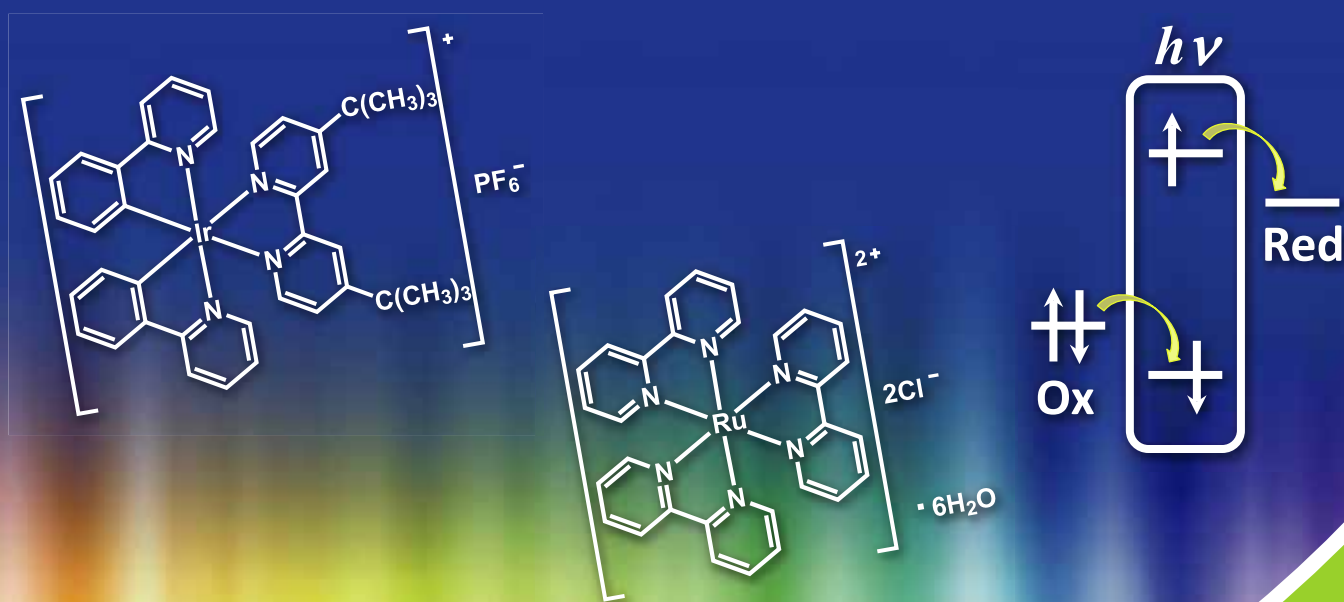


可见光光氧化还原催化剂

Visible Light Photoredox Catalysts



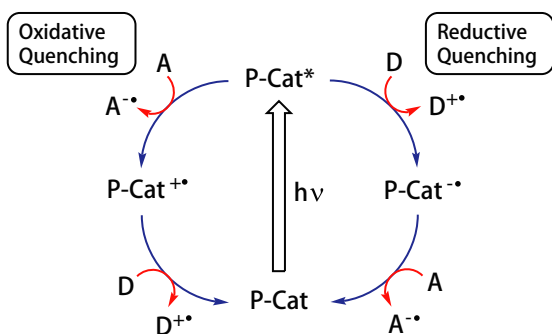
金属配合物催化剂

有机催化剂

可见光光氧化还原催化剂

光反应经历一种特殊的分子转化，生成的产物是通过热反应不能得到的。近来，可见光诱导的光反应得到了深入的研究。可见光条件下的光反应不需要高能量的UV光，并且反应条件温和，可以避免生成预期之外的副产物。

可见光照射下用于单电子氧化和还原的光催化剂，又被称为“可见光光氧化还原催化剂”，其有可能作为太阳能使用，因此引起了诸多关注¹⁾。使用光氧化还原催化剂的反应极易进行，而热反应在氧化剂和还原剂共存的条件往往很难发生。光氧化还原催化剂参与的反应循环包含了氧化和还原两种路径，因此总体呈现“氧化还原-中性(redox-neutral)”的反应机理。

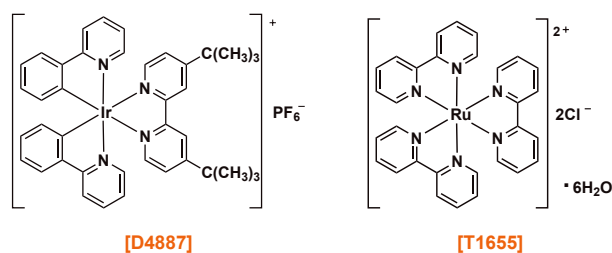


通过氧化和还原的路径进行光氧化还原催化

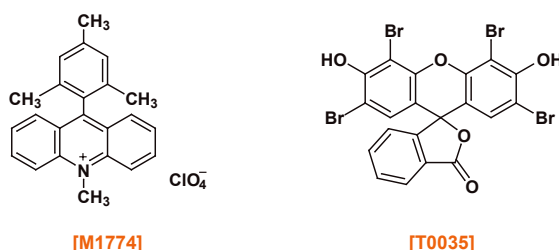
自由基种类的形成通常需要高能量的光辐射、氧化还原反应、热活化等外部必要的刺激。光催化研究领域开发出了过渡金属配合物催化剂和有机催化剂，这些催化剂在诸如可见光照射等温和的条件下即可形成自由基。

一些多吡啶钌(II)配合物和苯基吡啶铱(III)配合物都可以在可见光照射下作为光氧化还原催化剂使用²⁾。这些过渡金属配合物可以在光致辐照条件下产生长寿命激发三重态，因此是非常有效的光催化剂。对配体进行化学修饰可以控制这些过渡金属配合物的氧化还原电位³⁾。非金属有机催化剂也已被开发出来。一些含有供体-受体结构的吡啶化合物在可见光的照射下，其激发态会显示出长寿命电荷分离，因此也可以用作光氧化还原催化剂⁴⁾。此外，有报道指出伊红和氧杂蒽染料也可作为光氧化还原催化剂使用⁵⁾。

过渡金属光氧化还原催化剂

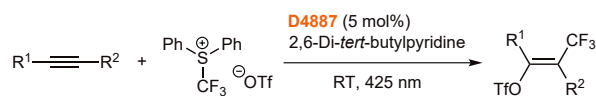


非过渡金属光氧化还原催化剂

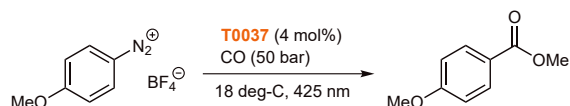


● 可见光光氧化还原催化剂反应示例

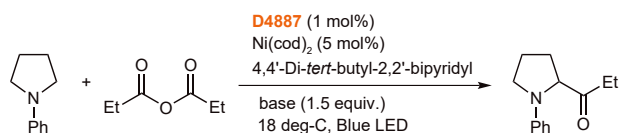
(1) 三氟甲基化反应⁶⁾



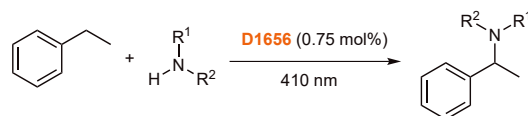
(2) 羧基化反应⁷⁾



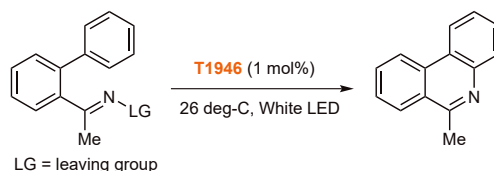
(3) C-H键直接酰化反应⁸⁾

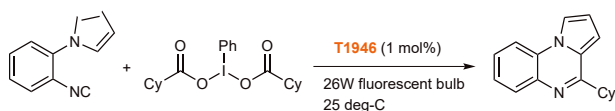


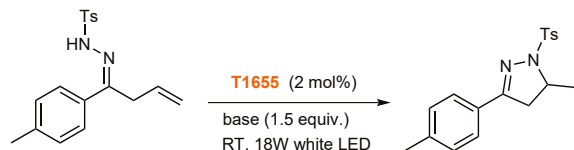
(4) C-H键直接胺化反应⁹⁾



(5) 亚胺基自由基的形成¹⁰⁾



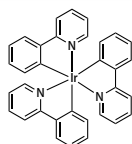
(6) 喹啉衍生物的合成¹¹⁾

 (7) 通过[3+2]环加成合成噁唑¹²⁾

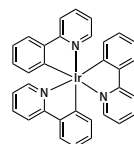
 (8) 胺基自由基的形成¹³⁾


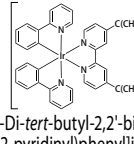
参考文献

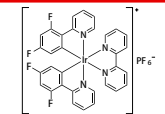
- 1) Review: Y. Xi, H. Yi, A. Lei, *Org. Biomol. Chem.* **2013**, *11*, 2387.
- 2) K. Zeitler, *Angew. Chem. Int. Ed.* **2009**, *48*, 9785.
- 3) Review: J. W. Tucker, C. R. J. Stephenson, *J. Org. Chem.* **2012**, *77*, 1617.
- 4) Review: S. Fukuzumi, K. Ohkubo, *Org. Biomol. Chem.* **2014**, *12*, 6059.
- 5) Review: D. P. Hari, B. Koenig, *Chem. Commun.* **2014**, *50*, 6688.
- 6) R. Tomita, T. Koike, M. Akita, *Angew. Chem. Int. Ed.* **2015**, *54*, 12923.
- 7) M. Majek, A. Jacobi von Wangelin, *Angew. Chem. Int. Ed.* **2015**, *54*, 2270.
- 8) C. L. Joe, A. G. Doyle, *Angew. Chem. Int. Ed.* **2016**, *55*, 4040.
- 9) G. Pandey, R. Laha, *Angew. Chem. Int. Ed.* **2015**, *54*, 14875.
- 10) H. Jiang, X. An, K. Tong, T. Zheng, Y. Zhang, S. Yu, *Angew. Chem. Int. Ed.* **2015**, *54*, 4055.
- 11) Z. He, M. Bae, J. Wu, T. F. Jamison, *Angew. Chem. Int. Ed.* **2014**, *53*, 14451.
- 12) T.-T. Zeng, J. Xuan, W. Ding, K. Wang, L.-Q. Lu, W.-J. Xiao, *Org. Lett.* **2015**, *17*, 4070.
- 13) X.-Q. Hu, J.-R. Chen, Q. Wei, F.-L. Liu, Q.-H. Deng, A. M. Beauchemin, W.-J. Xiao, *Angew. Chem. Int. Ed.* **2014**, *53*, 12163.

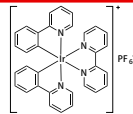
 金属配合物催化剂
 Metal Complex Catalysts

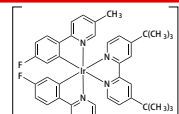
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 Ir(ppy)₃
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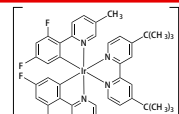
T1946 200mg

 Ir(ppy)₃ (purified by sublimation)
 CAS RN: 94928-86-6

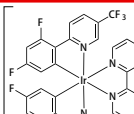
D4887 200mg

 (4,4'-Di-tert-butyl-2,2'-bipyridine)-
 bis(2-pyridinyl)phenyliridium(III)
 Hexafluorophosphate
 CAS RN: 676525-77-2

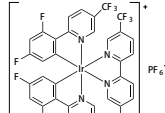
B4944 200mg

 (2,2'-Bipyridine)bis[2-(2,4-
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 iridium(III) Hexafluorophosphate
 CAS RN: 864163-80-4

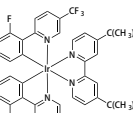
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 Hexafluorophosphate
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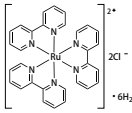
B6258 200mg 1g

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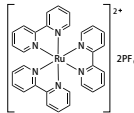
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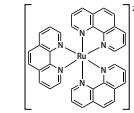
B6161 200mg 1g

 [Ir(dF(CF₃)ppy)₂(bpy)]PF₆
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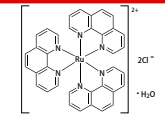
B6451 100mg 500mg

 [Ir(dFCF₃ppy)₂-
 (5,5'-dCF₃bpy)]PF₆
 CAS RN: 1973375-72-2

D5817 200mg 1g

 [Ir(dF(CF₃)ppy)₂(dtbbpy)]-
 PF₆
 CAS RN: 870987-63-6

T1655 1g 5g

 Tris(2,2'-bipyridyl)-
 ruthenium(II) Chloride
 Hexahydrate
 CAS RN: 50525-27-4

T3435 1g

 Tris(2,2'-bipyridine)-
 ruthenium(II)
 Bis(hexafluorophosphate)
 CAS RN: 60804-74-2

T3208 200mg 1g

 Tris(1,10-phenanthroline)-
 ruthenium(II)
 Bis(hexafluorophosphate)
 CAS RN: 60804-75-3

T3902 1g

 Tris(1,10-phenanthroline)-
 ruthenium(II) Dichloride
 Monohydrate
 CAS RN: 304695-79-2

有机催化剂 Organic Catalysts		D1070 25g 250g	A0502 25g 500g	D1656 1g 5g
		 DDQ CAS RN: 84-58-2	 Anthraquinone CAS RN: 84-65-1	 9,10-Dicyanoanthracene CAS RN: 1217-45-4
M1787 250mg 1g	M1775 1g 5g	M1774 1g 5g	D3429 1g	D3428 1g 5g
 10-Methylacridinium Perchlorate CAS RN: 26456-05-3	 10-Methyl-9-phenylacridinium Perchlorate CAS RN: 36519-61-6	 9-Mesityl-10-methylacridinium Perchlorate CAS RN: 674783-97-2	 9-(2,6-Dimethylphenyl)-10-methylacridinium Perchlorate CAS RN: 1276539-32-2	 9-(2,5-Dimethylphenyl)-10-methylacridinium Perchlorate
B2897 1g 5g	M2072 1g	D5983 200mg 1g	P2470 1g 5g	P3081 200mg 1g
 9-(2-Biphenyl)-10-methylacridinium Perchlorate	 9-Mesityl-2,7,10-trimethylacridinium Perchlorate CAS RN: 1216909-33-9	 Acr-450 CAS RN: 2771238-32-3	 10-Phenylphenothiazine CAS RN: 7152-42-3	 Ph-benzoPTZ CAS RN: 1320277-85-7
R0040 25g 250g	R0039 25g	R0041 25g	T0035 25g	T0037 25g
 Rhodamine B CAS RN: 81-88-9	 Rhodamine 6G CAS RN: 989-38-8	 Rose Bengal CAS RN: 632-69-9	 Eosin Y CAS RN: 15086-94-9	 Eosine CAS RN: 17372-87-1
T0124 25g	T0557 25g	R0020 25g 100g 500g	R0055 5g 25g	T1445 1g
 Iodoeosine CAS RN: 15905-32-5	 Erythrosine B CAS RN: 16423-68-0	 Riboflavin CAS RN: 83-88-5	 Riboflavin Tetrabutyrate CAS RN: 752-56-7	 2,4,6-Triphenylpyrylium Hydrogensulfate CAS RN: 51071-75-1
T3968 1g	X0005 25g	X0083 1g		
 2,4,6-Triphenylpyrylium Tetrafluoroborate CAS RN: 448-61-3	 Xanthone CAS RN: 90-47-1	 peri-Xanthenoxanthene CAS RN: 191-28-6		

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