Institut des Sciences Moléculaires de Marseille
UMR 6263

RCC (HBR)

Oxidative Cleavage of Alkenes Using an *In Situ* Generated Iodonium Ion with Oxone as a Terminal Oxidant

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Thottumkara, P. P.; Vinod, T. K.

I- Precedents for cleavage of double bonds

1) Old ones:

- Ozonolysis[1] ↪ Risk of Explosion (Ouch!)

- Lemieux-Johnson protocol:[2] OsO_4 followed by $NaIO_4$

↪ Toxicity (Re-ouch!)

- High valent metal-oxo catalysts of Mn, Mo, Ru, Pd, Re and Os with a co-oxidant to regenerate

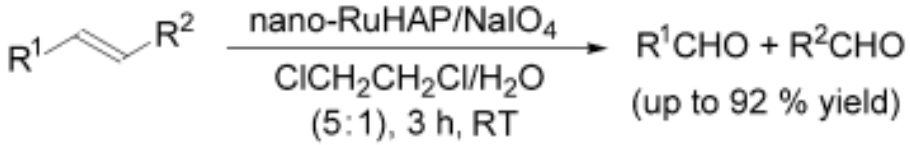
↪ Toxicity and Inability to recover 100% of the spent reagent

↪ Obstruction to use these methods in industrial process

1. Serious accidents have been reported: Koike, K; Inoue, G; Fukada, T. *J. Chem. Eng. Jpn.* **1999**, *32*, 295
2. Pappo, R.; Allen, D. S. Jr.; Lemieux, R. U.; Johnson, W. S. *J. Org. Chem.* **1956**, *21*, 478

2) Recent Improvements

a) Immobilization or microencapsulation of the Metal catalyst on polymers[3]



b) Organoiodine reagents

- Ochiai *et al.* introduced environmentally benign organoiodine reagents[4]

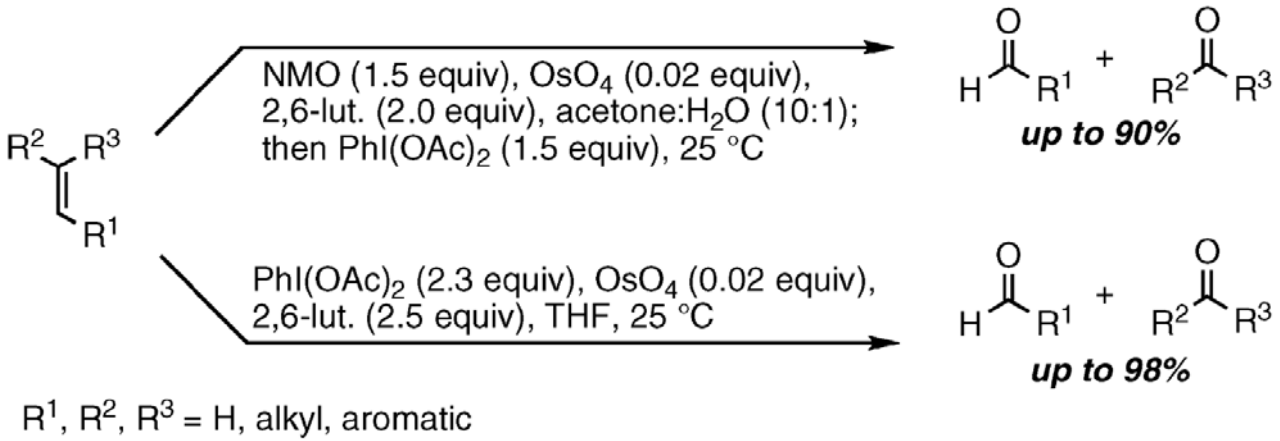
- PhIO, 48% HBF_4, 18-crown-6

- ArI(*cat.*), 48% HBF_4, *m*-CPBA

3. Ho, C.-M. *et al. ACIE*, **2004**, *43*, 3303
4. a. Miyamoto, K. *et al. JACS*, **2007**, *129*, 2772; b. Miyamoto, K. *et al. JACS*, **2009**, *131*, 1382

- Most recently, Nicolaou *et al.* reported:

Upjohn conditions[5] hydroxylation followed by the addition of Ph(IOAc)2



Need for simple and non toxic protocols

5. Van Rheeven, V. *et al. Tetrahedron Lett.* **1976**, *23*, 1973
6. Nicolaou, K. C. *et al. Org. Lett.* **2010**, *12*, 1552

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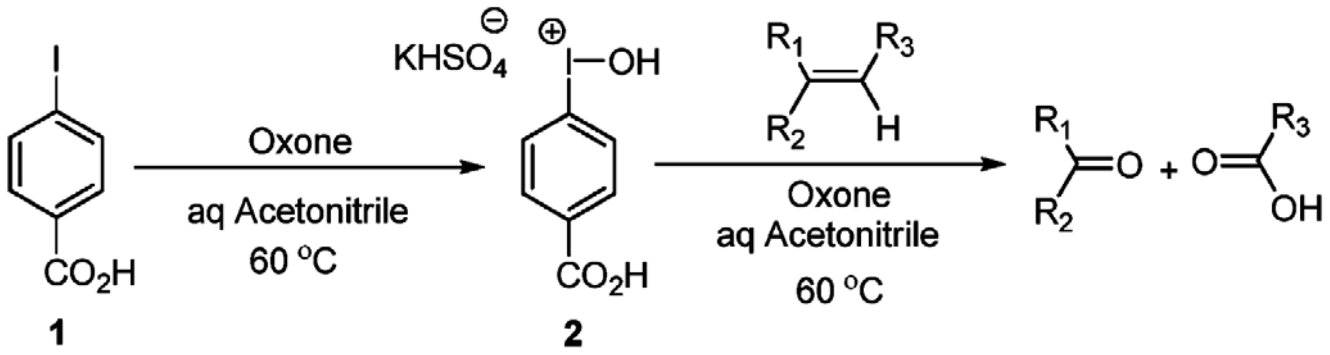
3) HBR



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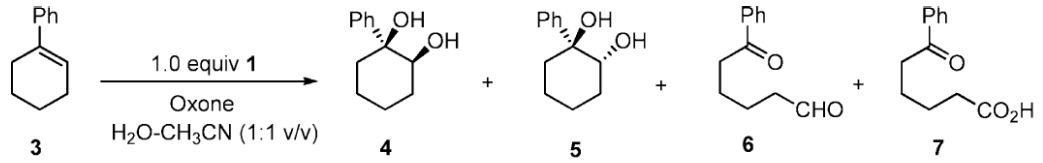
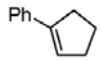
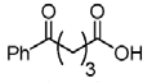
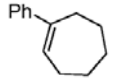
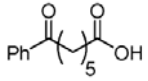
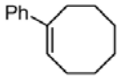
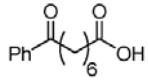
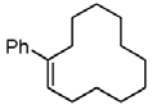
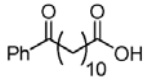
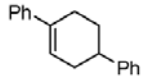
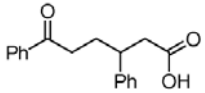
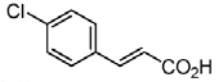
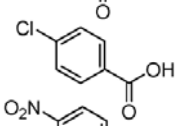
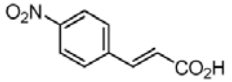
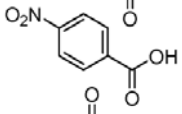
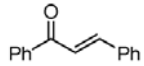
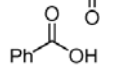
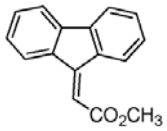
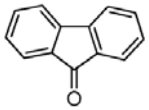
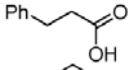
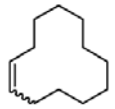
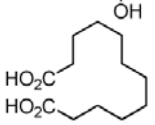
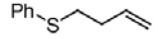
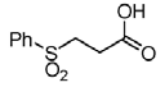
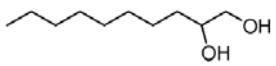
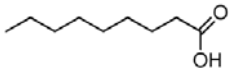
Optimization



	equiv		% yield[b]		
entry	**1**	oxone	(**4** + **5**)	**6**	**7**
1	–	0.5[c]	95	–	–
2	–	1.0[c]	100	–	–
3	1.0	0.5	95	5	–
4	1.0	0.75	69	7	24
5	1.0	1.0	45	15	40
6	1.0	1.2	25	10	65
7	1.0	1.5	8[d]	–	92
8	1.0	1.63	3[d]	5	92
9	1.0	2.0	–	–	100
10	0.5	2.0	–	–	100
11	0.25	2.0	–	–	100
12	0.05	2.0	–	–	100

[a] Reactions were carried out on 0.2 g scale in H_2O:CH_3CN (1:1 v/v, 20 mL) at 60 °C for 3 h. [b] ^1H NMR yield. [c] No 4-IBAcid present. [d] Exclusively **5** with no **4** present.

Substrate Scope

entry	substrate	method[a]	time h	product	yield, %
1		A	3		90[b]
2		A	3		76[b]
3		B	4		78[b]
4		A	3		80[b]
5		B	3		65[b]
6		A	6		83[c]
7		A	14		81[c]
8		A	14		90[c]
9		A	18		87[c]
10		A	14		33[c]
11		C	8		90[b]
12		C	8		82[c]
13		C	8		70[b]
14		C	8		86[c]

a. **Method A**

0.2 eq of **1** and Oxone in H_2O-CH_3CN (1:1)

Method B

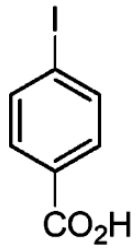
0.2 eq of Iodobenzene and Oxone in H_2O-CH_3CN (1:1)

Method C

1.0 eq of Iodobenzene and Oxone in H_2O-CH_3CN (1:1)

b. Isolated yield

c. ^1H NMR yield



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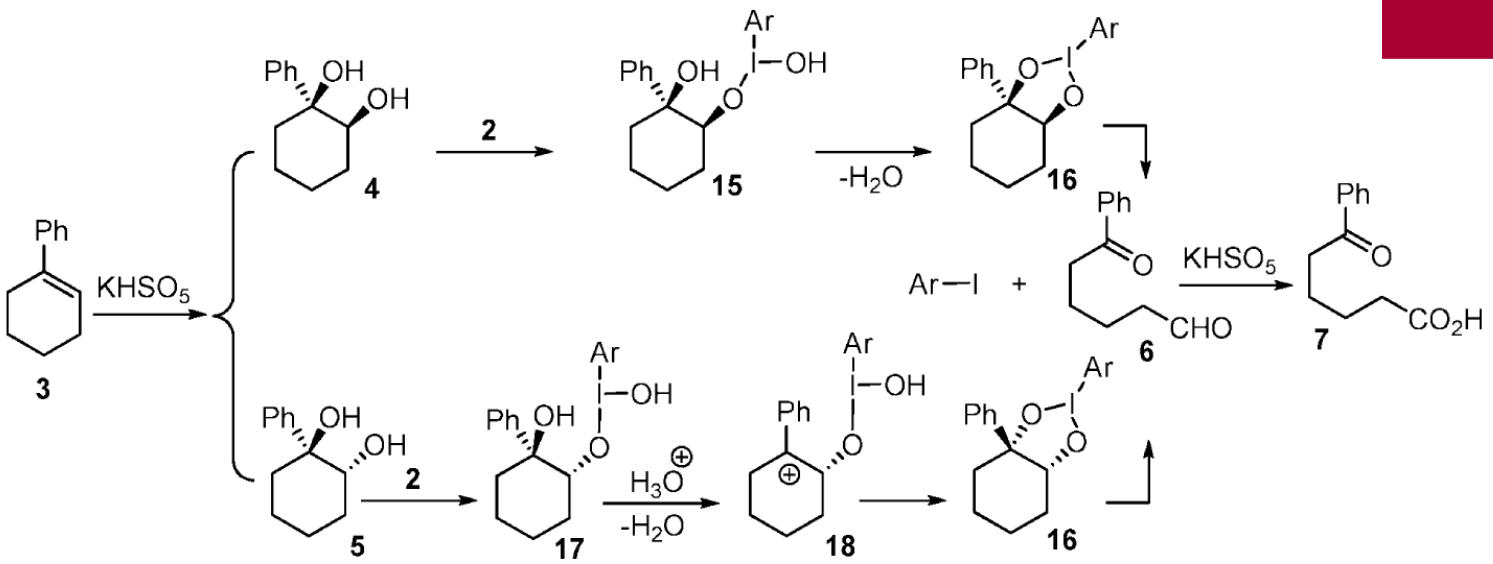
Mechanism



3) Conclusion

In summary we have developed an operationally simple and catalytic procedure for oxidative cleavage of alkenes using benign and cheap reagents. The new method is versatile and a safer alternative to existing alkene cleavage procedures.

Vinod, T. K.