

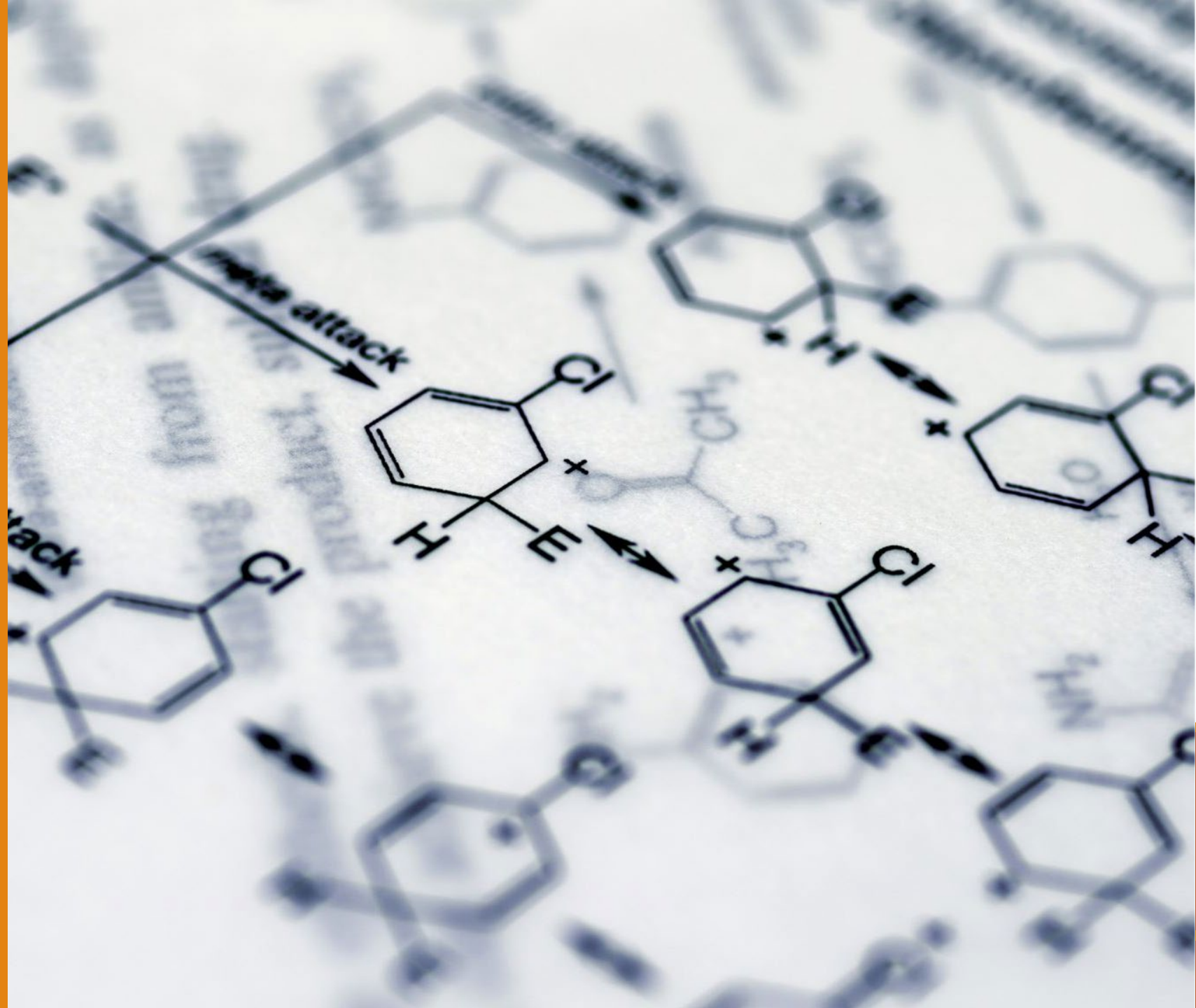
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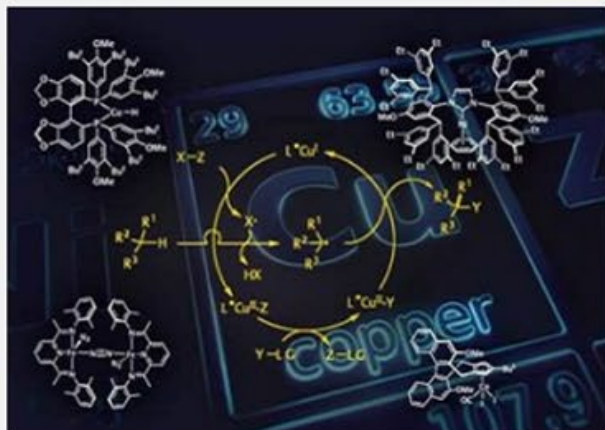
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# Base-Metal Catalysis

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**38.11.3.1 Acid-Catalyzed Reaction of Carbonyl Compounds with Hydroperoxides**

DOI: 10.1055/sos-SD-138-00067

Vil', V. A.; Bityukov, O. V.; Terent'ev, A. O., *Science of Synthesis Knowledge Updates*, (2019) **3**, 408.

The reaction of carbonyl compounds **62** with *tert*-butyl hydroperoxide provides geminal di-*tert*-butyl peroxides **63** (Scheme 28). Synthesis proceeds in the presence of sulfuric, [128-131] hydrochloric, [132-136] perchloric, [133,137-142] 4-toluenesulfonic, [143] and other acids, usually with the use of dehydrators (CaCl<sub>2</sub>, Na<sub>2</sub>SO<sub>4</sub>, B<sub>2</sub>O<sub>3</sub>, etc.) at 0–60 °C. Molecular iodine can also be used as catalyst. [92]

**Scheme 28** Acid-Catalyzed Synthesis of Geminal Bisperoxides from Carbonyl Compounds and *tert*-Butyl Hydroperoxide [92,128-143]

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R <sup>1</sup>	R <sup>2</sup>	<i>t</i> -BuOOH (Equiv)	Conditions	Yield (%)	Ref
H	Et	2	35% HCl, 0–30 °C	76	[132]
H	Pr	2	70% HClO <sub>4</sub> , 5–7 °C, then rt, then 60 °C	85	[133]
H	<i>i</i> Pr	2	70% HClO <sub>4</sub> , 5–7 °C, then rt, then 60 °C	80	[133]
H	2-FC <sub>6</sub> H <sub>4</sub>	2	35% HClO <sub>4</sub> , CaCl <sub>2</sub> , benzene, 0–40 °C	85	[137]

**NAVIGATION**

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(CH<sub>2</sub>)<sub>5</sub> *t*-Bu 1.1 40% aq HBF<sub>4</sub>, pentane, rt, 2 h 33 [147]

**2,2-Bis(*tert*-butylperoxy)-1-phenylpropane (63, R<sup>1</sup>=Bn; R<sup>2</sup>=Me); Typical Procedure by Catalysis with Concentrated Hydrochloric Acid: [136]**

In a 50-mL, round-bottomed flask, 1-phenylpropan-2-one (**62**, R<sup>1</sup>=Bn; R<sup>2</sup>=Me; 1 g, 7.46 mmol) was dissolved in hexanes (6 mL) and the soln was cooled to 0 °C (ice bath). Ground CaCl<sub>2</sub> (500 mg) was added, followed by 70% aq *t*-BuOOH (4 mL, 29.2 mmol) and concd HCl (0.5 mL), making sure the temperature did not exceed 5 °C. The resulting mixture was vigorously stirred at 0 °C for 4 h. Hexane (30 mL) was added and the phases were separated. The organic phase was then successively washed with 2 M aq NaOH (15 mL) and distilled H<sub>2</sub>O (2 × 15 mL), dried (Na<sub>2</sub>SO<sub>4</sub>), filtered, and concentrated. The resulting clear liquid was purified by flash chromatography (silica gel prewashed with hexane containing 1% Et<sub>3</sub>N, hexane) to afford the product as a white solid; yield: 1.85 g (83%).

**4-*tert*-Butyl-1,1-bis(*tert*-butylperoxy)cyclohexane [63, R<sup>1</sup>,R<sup>2</sup>=(CH<sub>2</sub>)<sub>2</sub>CH(*t*-Bu)(CH<sub>2</sub>)<sub>2</sub>]; Typical Procedure by Molecular Iodine Catalysis: [92]**

To a soln of I<sub>2</sub> (25.4 mg, 0.1 mmol, 10 mol%) and 60% *t*-BuOOH in decane (0.72 mL, 2 mmol) in MeCN (1 mL) was added 4-*tert*-butylcyclohexanone [**62**, R<sup>1</sup>,R<sup>2</sup>=(CH<sub>2</sub>)<sub>2</sub>CH(*t*-Bu)(CH<sub>2</sub>)<sub>2</sub>; 154 mg, 1 mmol], and the soln was stirred at 22 °C for 24 h. The mixture was concentrated under reduced pressure (ca. 20 Torr), and the product was isolated by column chromatography (silica gel, petroleum ether/Et<sub>2</sub>O 95:5); yield: 259 mg (82%).

**Geminal Bisperoxides 69; General Procedure by Tetrafluoroboric Acid Catalysis: [146]**

**CAUTION:** Tetrafluoroboric acid is extremely destructive to the skin, eyes, and respiratory tract.

50% aq HBF<sub>4</sub> (2–4 mmol) was added to a mixture of the acetal **67** (5 mmol), 70% aq *t*-BuOOH (**68**, R<sup>3</sup>=*t*-Bu; 15–25 mmol), CaCl<sub>2</sub> (0.56 g, 5 mmol), and petroleum ether (35 mL). The mixture was stirred at rt until the acetal had been completely converted (20–180 min, TLC monitoring). Petroleum ether (bp 40–70 °C; 20 mL) was added, and the organic phase was washed with 5% aq NaOH (30 mL) and H<sub>2</sub>O (2 × 20 mL), dried (Na<sub>2</sub>SO<sub>4</sub>), filtered, and concentrated.

**References**

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