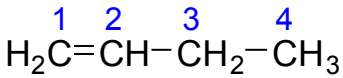
Alkene: C_nH_{2n} (n = 2, 3,...)

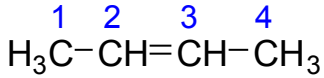
C_2H_4: $H_2C{=}CH_2$ Ethen (Ethylen)

C_3H_6: $H_2C{=}CH{-}CH_3$ Propen (Propylen)

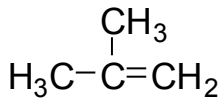
C_4H_8: Buten (Struktur- und Stereoisomere)



1-Buten

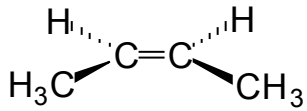


2-Buten

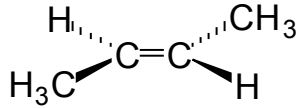


Methylpropen (Isobuten)

(Strukturisomere)



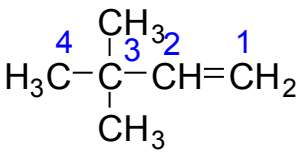
cis- oder *Z*-2-Buten



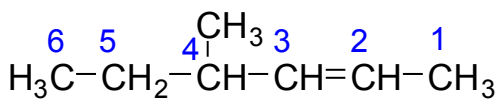
trans- oder *E*-2-Buten

(*Z* - *Z*usammen, *E* - *E*ntgegen)

IUPAC-Nomenklatur

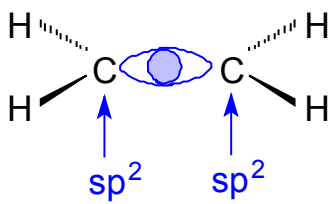


3,3-Dimethyl-1-buten

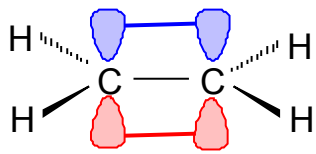


4-Methyl-2-hexen

σ-Gerüst



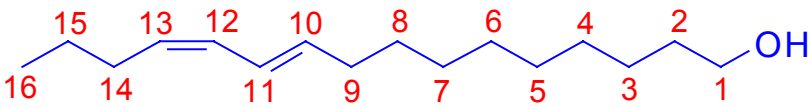
σ-CC-Bindung



π-CC-Bindung

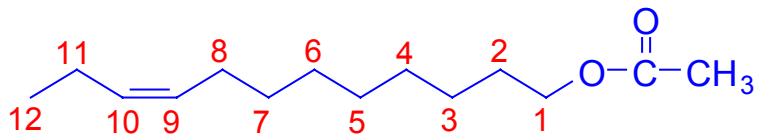
Pheromone: Sexuallockstoffe von Insekten

Beispiele:



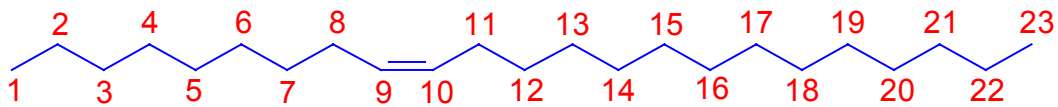
(10*E*, 12*Z*)-10,12-Hexadecadien-1-ol

Sexuallockstoff des Seidenspinners (Bombyx mori)



(*Z*)-9-Dodecen-1-ylacetat

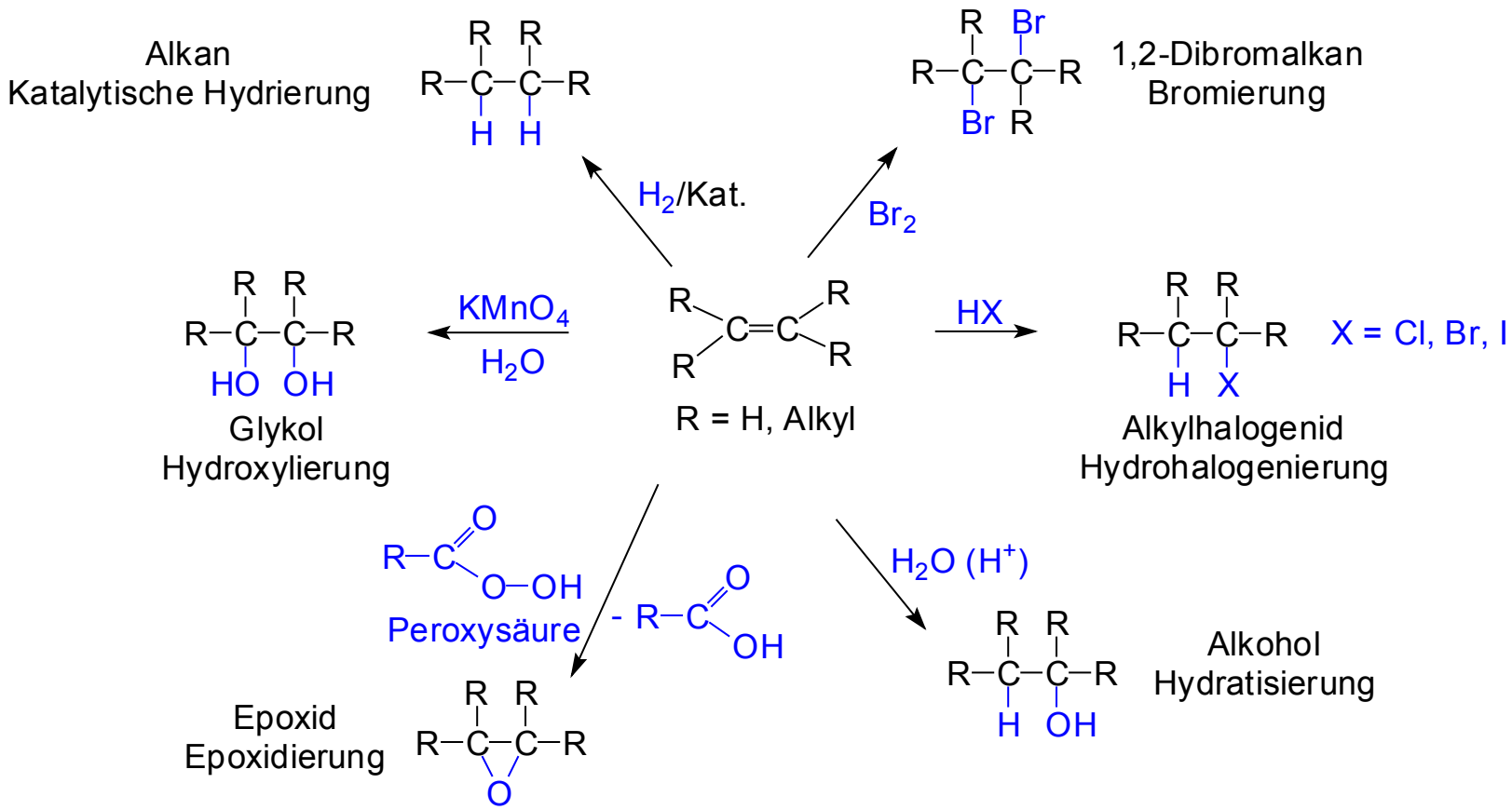
Sexuallockstoff des Traubenwicklers



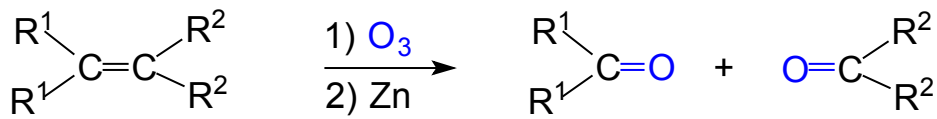
(*Z*)-9-Tricosen

Sexuallockstoff der Stubenfliege

Reaktionen von Alkenen: Addition an die π-Bindung



Fragmentierung von Alkenen: Ozonolyse

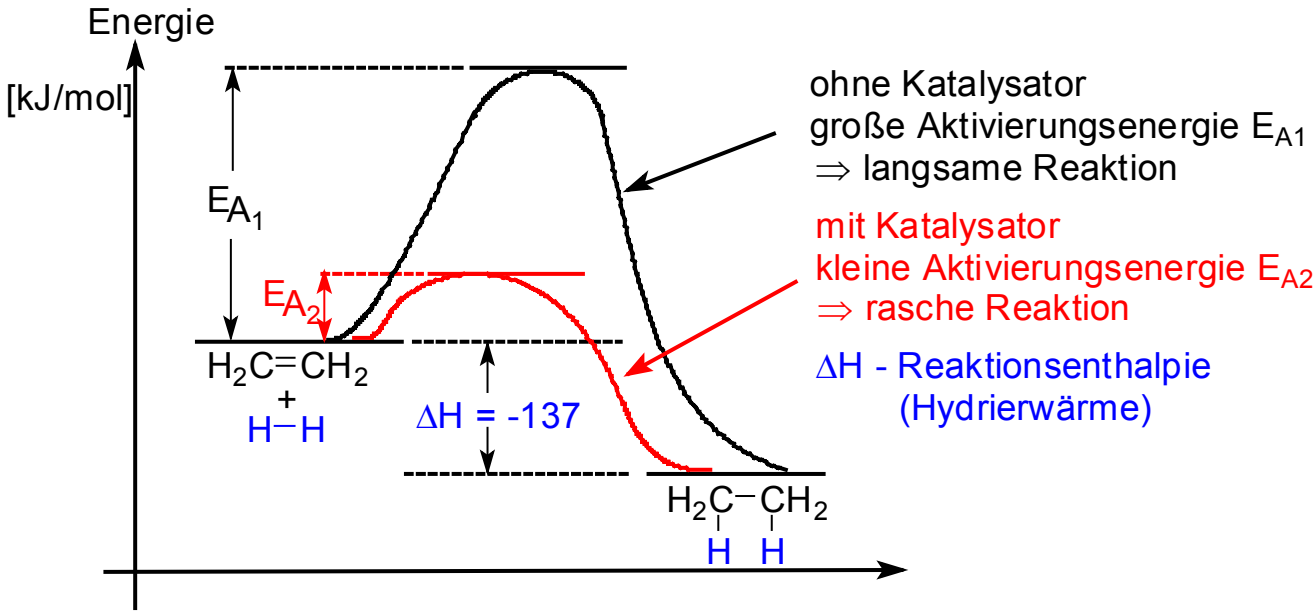


Heterogene Katalyse

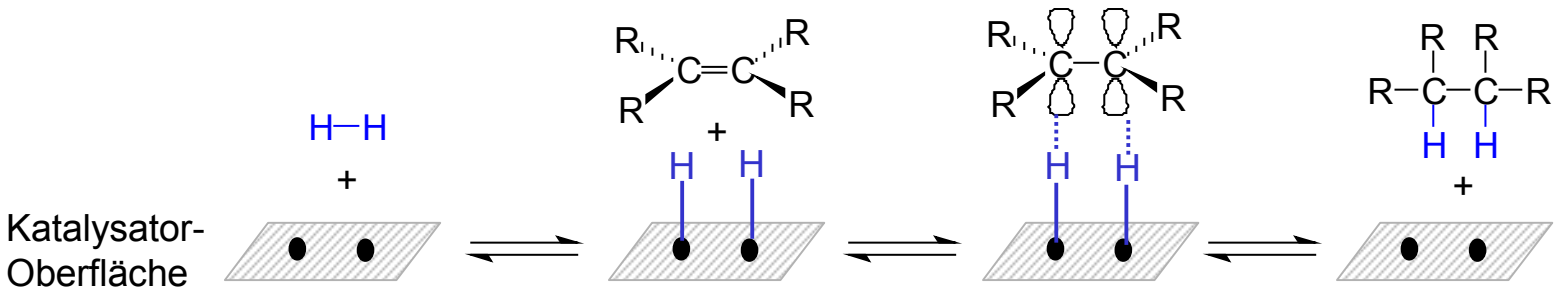
Katalysator und Reaktanden in unterschiedlicher Phase ; meist Katalysator als fein verteilter Feststoff (große Oberfläche), Reaktanden in Flüssig- oder Gasphase.

Homogene Katalyse

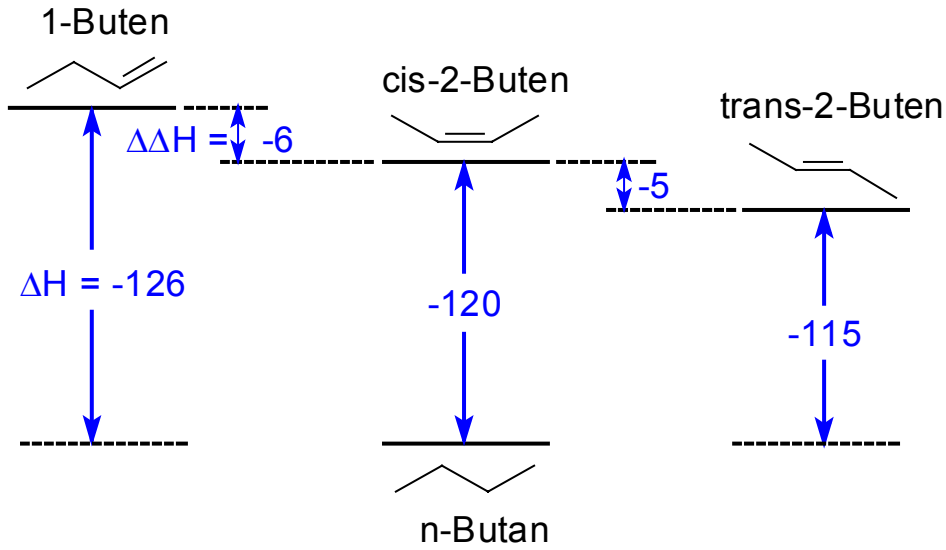
Katalysator und Reaktanden in einer Phase (meist in Lösung).



Katalysatoren für die Hydrierung: Pt, Pd auf Aktivkohle, Raney-Ni



ΔH-Werte in kJ/mol

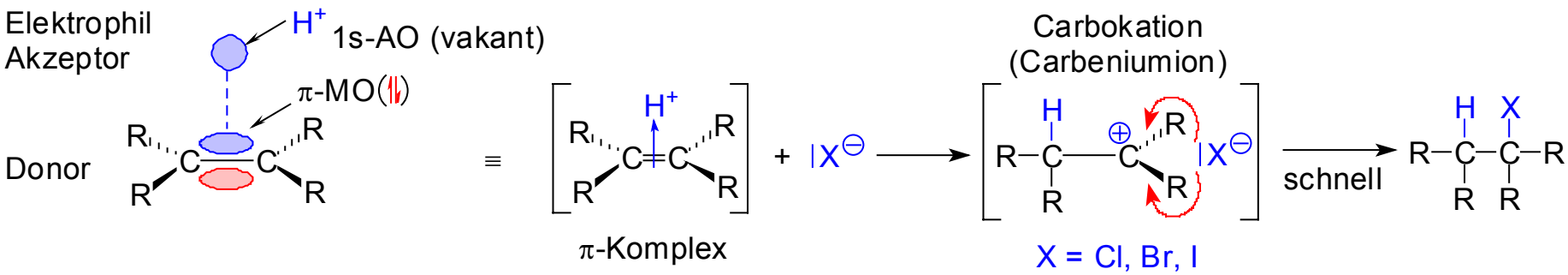


Stabilitätsreihe der Alkene

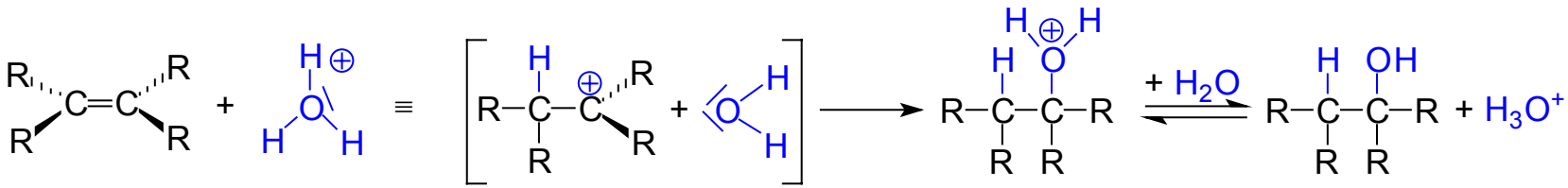
$R_2C{=}CR_2 > R_2C{=}CHR > R_2C{=}CH_2$, $RCH{=}CHR > RCH{=}CH_2 > CH_2{=}CH_2$

tetra- tri- di- mono- substituiert

Elektrophile Addition (elektrophil - Elektronen liebend)

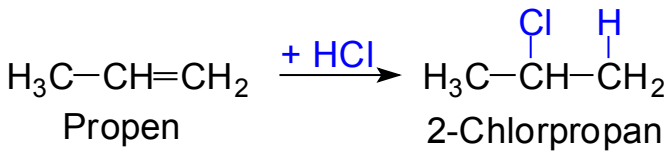


Hydratisierung



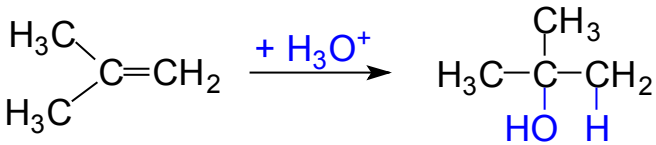
Markownikow-Regel: Bei unsymmetrisch substituierten Alkenen addiert sich das Elektrophil an das weniger substituierte C-Atom des Alkans.

Beispiele:



Propen — 2-Chlorpropan

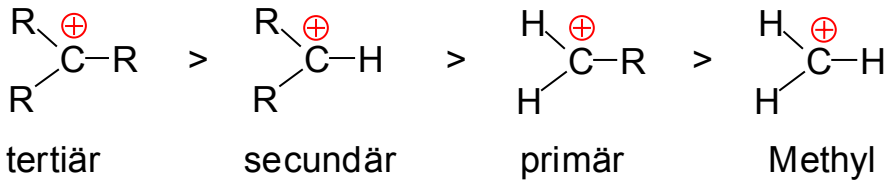
1-Chlorpropan $H_3C–CH_2–CH_2–Cl$ wird nicht gebildet



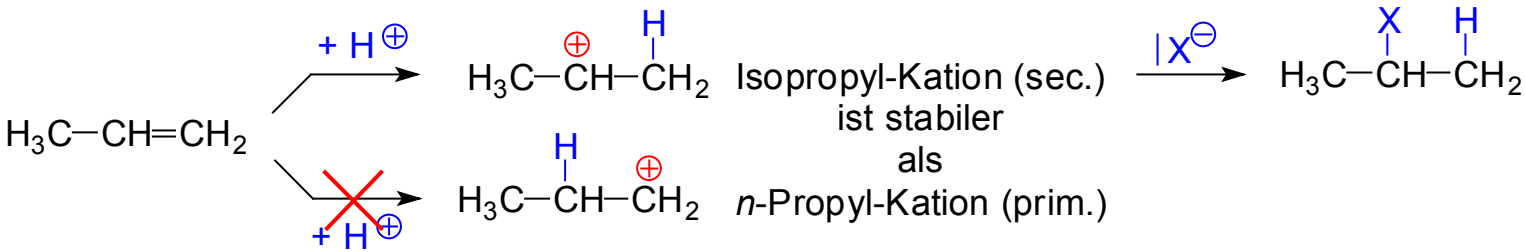
Isobuten (Methylpropen) — *tert.*-Butylalkohol (2-Methyl-2-propanol)

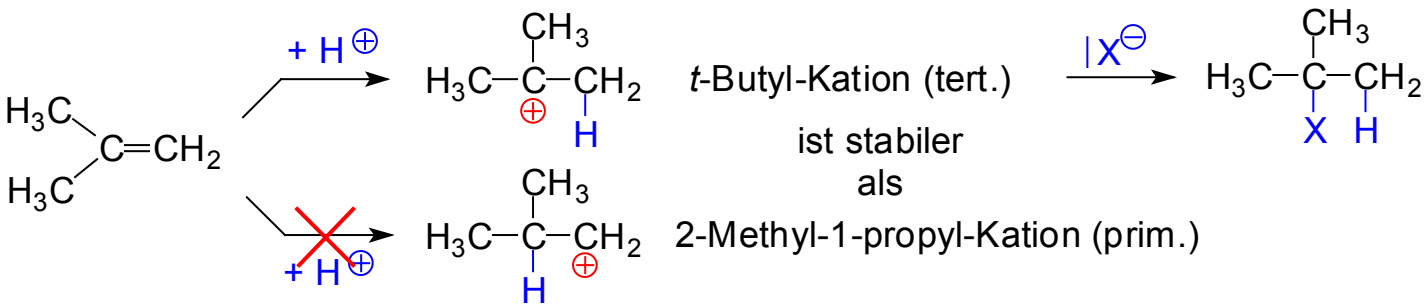
2-Methyl-1-propanol $(CH_3)_2CH–CH_2OH$ wird nicht gebildet

Erklärung mit Hilfe der Carbokation-Zwischenstufe

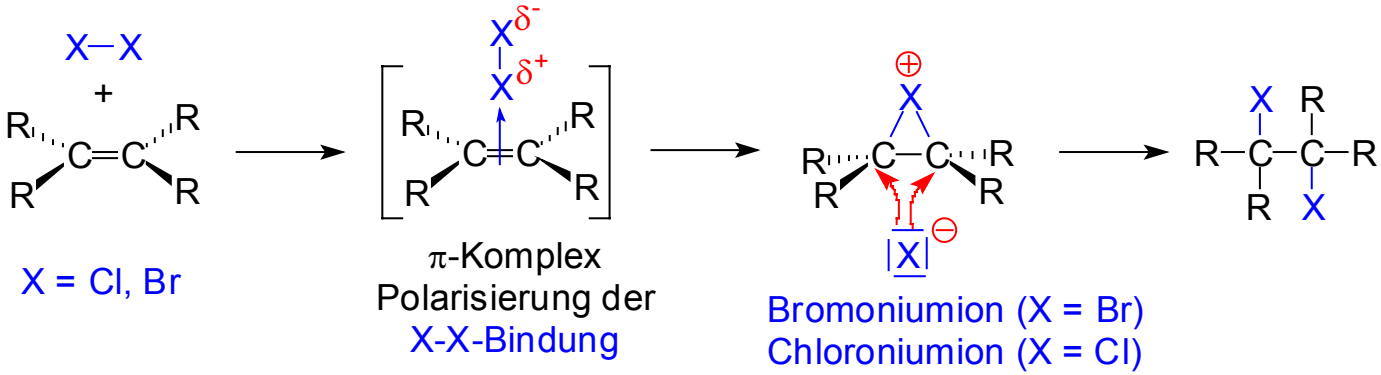


Stabilitätsreihe (analog der freien Radikale).

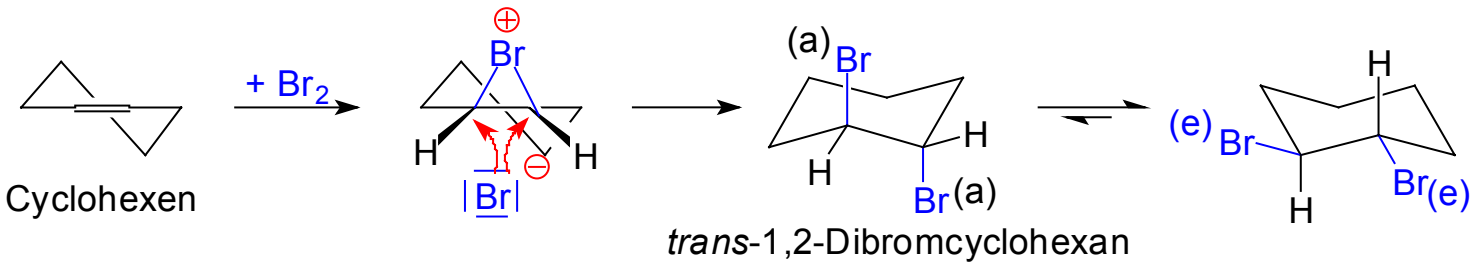




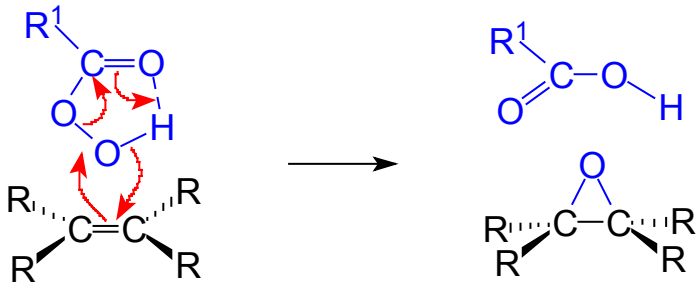
Halogenierung von Alkenen



trans-Addition

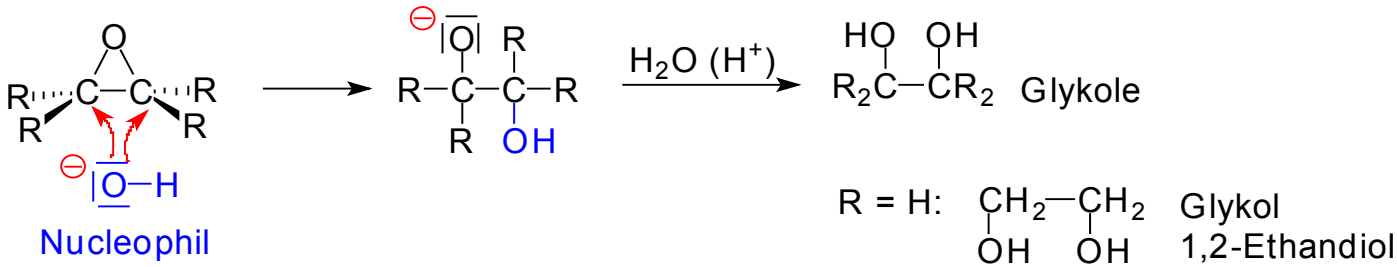


Epoxidierung



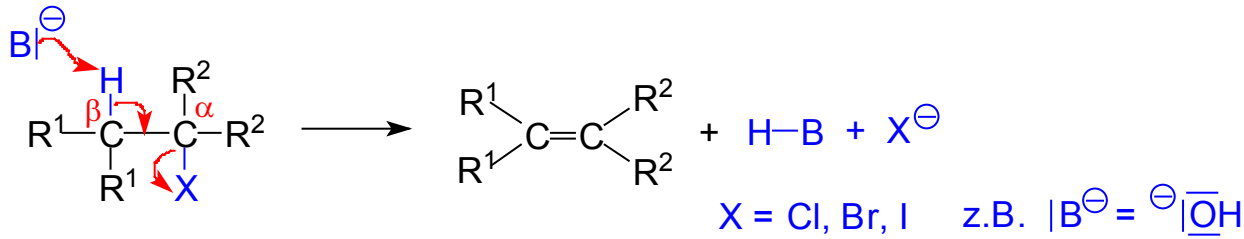
Epoxide sind hochgespannte Dreiring-Verbindungen analog zu den Cyclopropan-Derivaten.

△ Cyclopropan

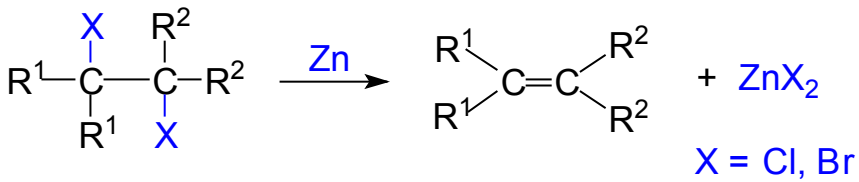


Synthese von Alkenen

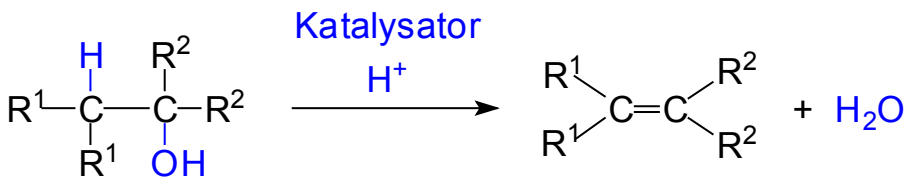
Durch 1,2- bzw. β-Eliminierung aus Alkylhalogeniden: Dehydrohalogenierung



Dehalogenierung aus vicinalen Dihalogeniden

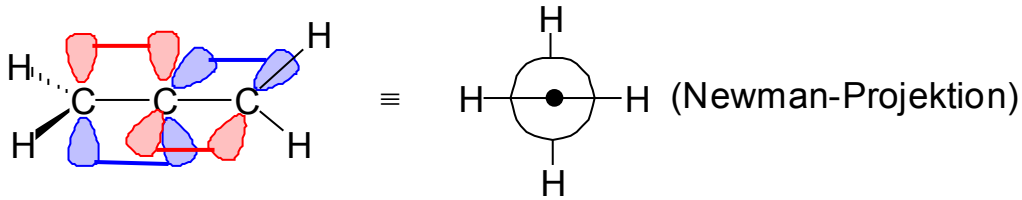


Dehydratisierung von Alkoholen (Umkehr der Alkoholbildung aus Alkanen)



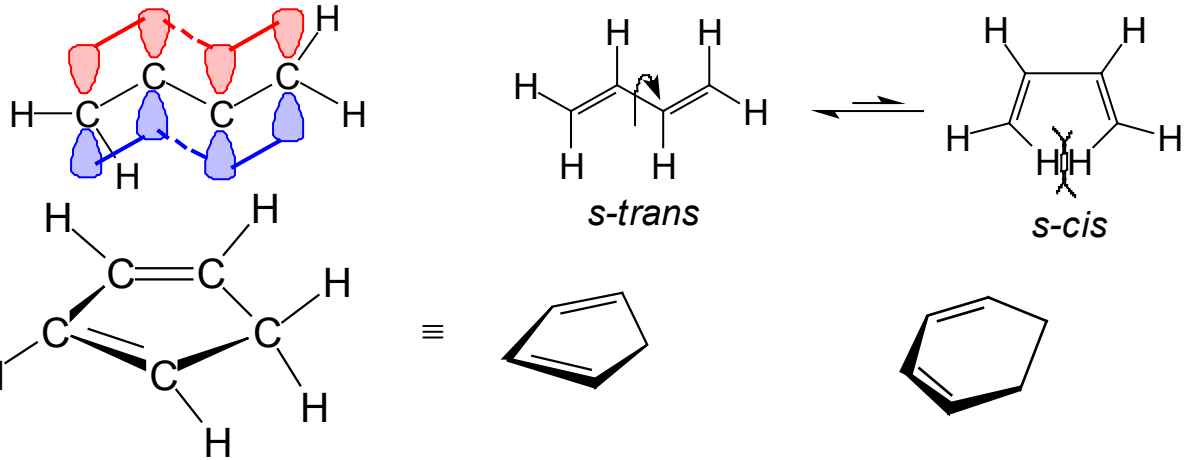
Diene und Polyene

kumulierte 1,2-Diene: Allen (1,2-Propadien) $H_2C{=}C{=}CH_2$ (sp^2 sp sp^2)



(Newman-Projektion)

konjugierte 1,3-Diene: 1,3-Butadien $H_2C{=}CH{-}CH{=}CH_2$ (1 2 3 4)



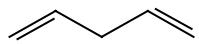
s-trans *s-cis*

1,3-Cyclopentadien

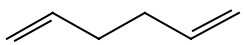
1,3-Cyclohexadien

sp^3 (Isolator)

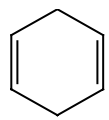
isolierte Diene: 1,4-Pentadien $H_2C{=}CH{-}CH_2{-}CH{=}CH$ ≡



Reaktivität vergleichbar mit der der einfachen Alkene

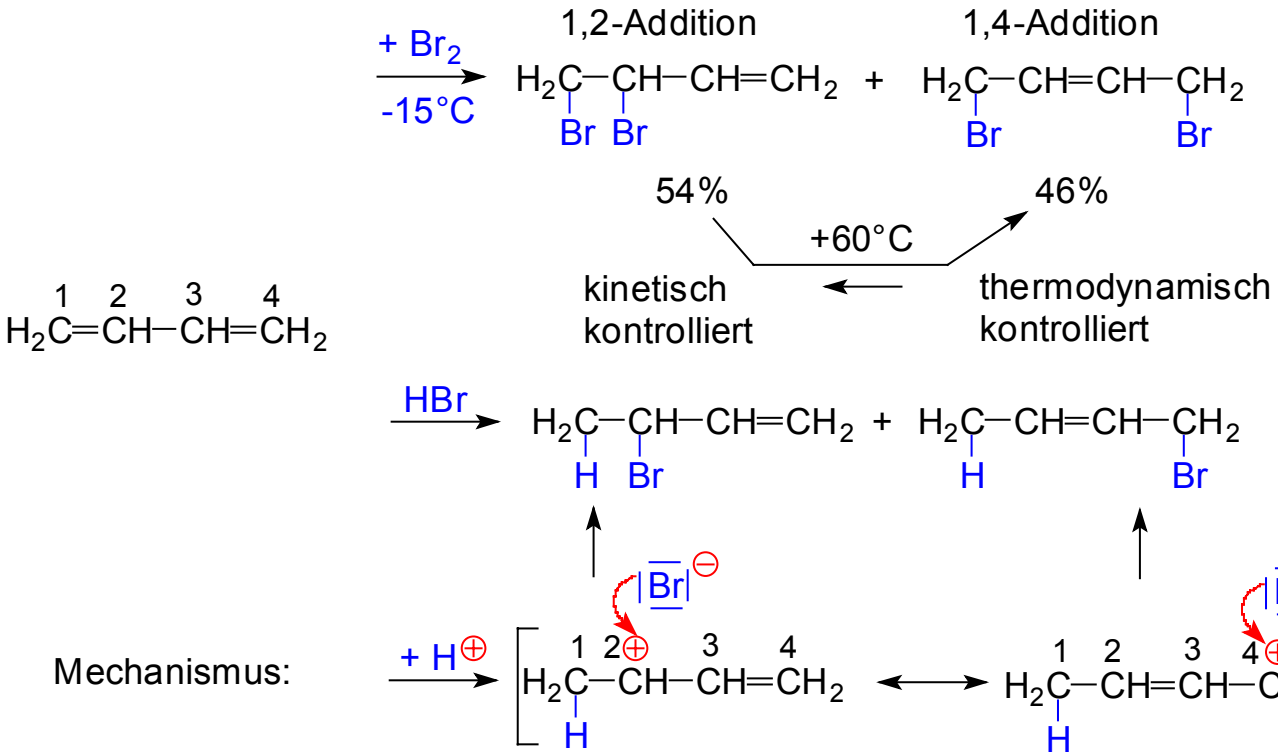


1,5-Hexadien

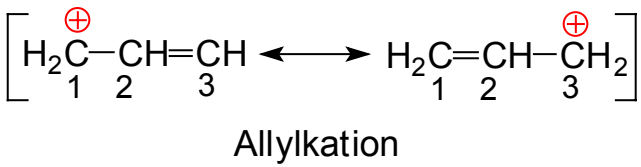


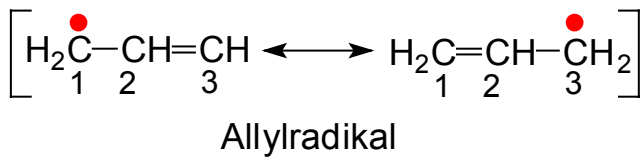
1,4-Cyclohexadien

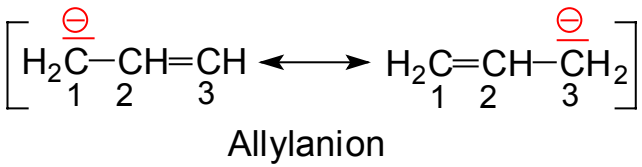
Reaktionen von 1,3-Dienen

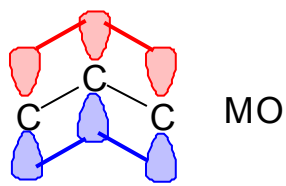


Allyl-Resonanz:

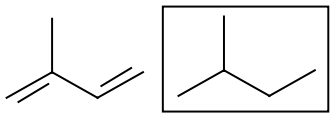






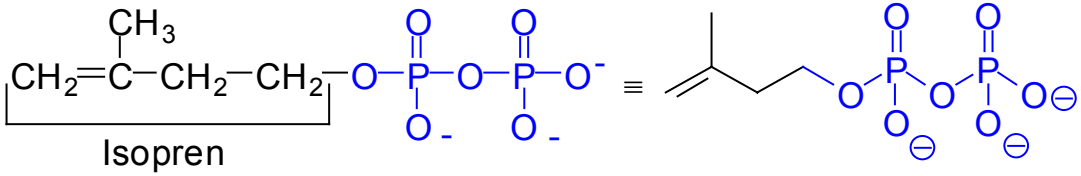


Biosynthese von Cholesterin aus aktiviertem Isopren

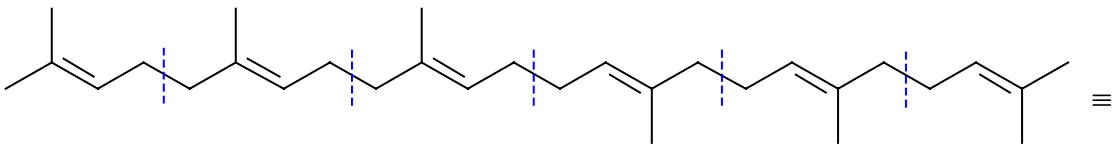


2-Methyl-1,3-butadien
Isopren

Isopren-Regel: Viele Naturstoffe sind aus Isopren-Einheiten aufgebaut. ⇒ Terpene



aktiviertes Isopren



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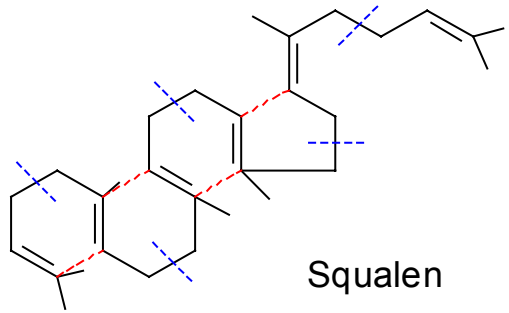
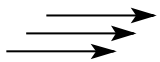
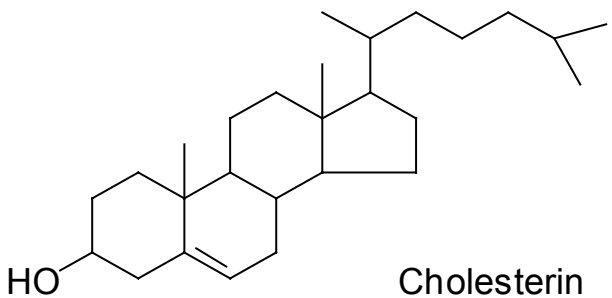


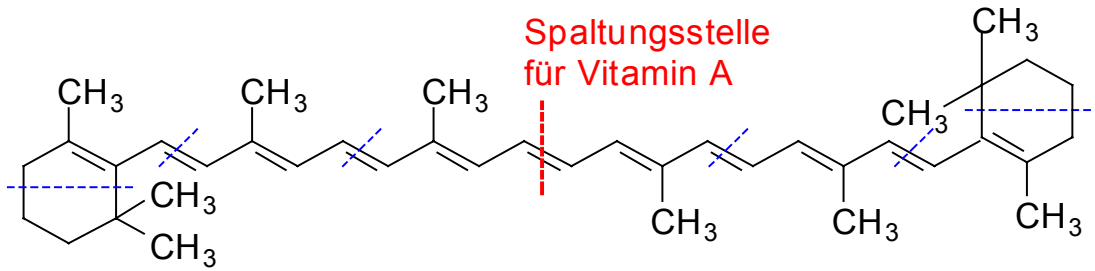
Squalen





Cholesterin

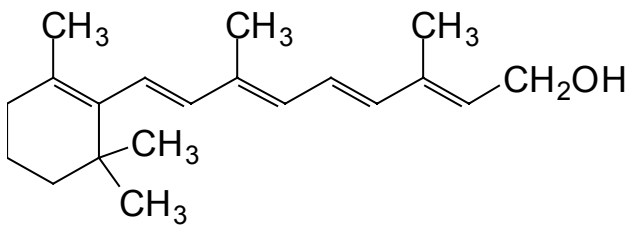
Weiteres Terpen



β-Carotin ($C_{40}H_{56}$)

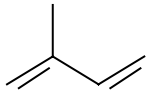
11 konjugierte Doppelbindungen: Farbe orange-rot

Aus Isopreneinheiten aufgebaut: Provitamin A



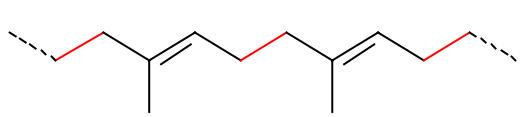
Vitamin A

Polymerisation von konjugierten Dienen



transoide Konformation
s-trans

Polymerisation →



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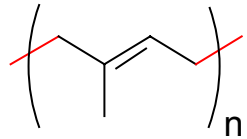
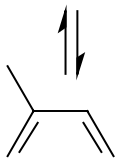


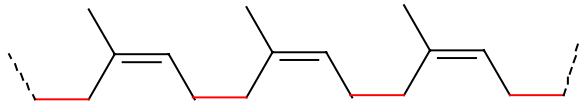
trans-Polyisopren
Guttapercha
hartes, wenig elastisches Polymer



cisoide Konformation
s-cis

Isopren

Polymerisation →



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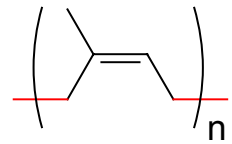
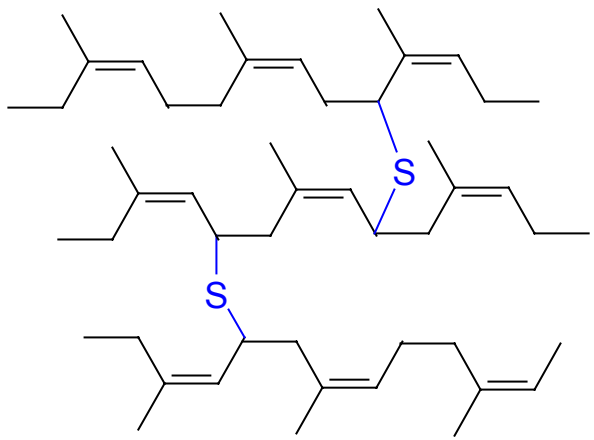
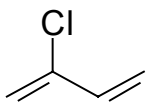


cis-Polyisopren
(Natürlicher Kautschuk)

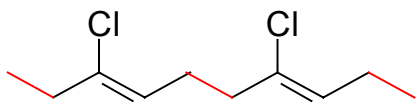
Elastomer nach Quervernetzung
einzelner Ketten mit Schwefelbrücken
⇒ Vulkanisieren





2-Chlor-1,3-butadien
Chloropren

$TiCl_4$
AlR_3 →



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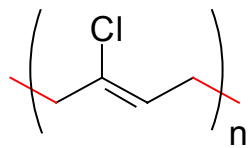
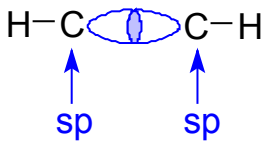


Neopren: elastisches, hitze- und
sauerstoffbeständiges Polymer

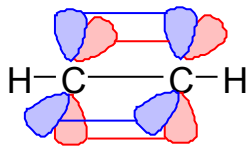
Alkine: C_nH_{2n-2} (n = 2, 3, ...)

C_2H_2:	$HC{\equiv}CH$	Ethin (Acetylen)
C_3H_4:	$HC{\equiv}C{-}CH_3$	Propin (Methylacetylen)
C_4H_6:	$\overset{1}{H}C{\equiv}\overset{2}{C}{-}\overset{3}{C}H_2{-}\overset{4}{C}H_3$	1-Butin (Ethylacetylen)
	$H_3\overset{1}{C}{-}\overset{2}{C}{\equiv}\overset{3}{C}{-}\overset{4}{C}H_3$	2-Butin (Dimethylacetylen)

Struktur von Acetylen im Vergleich zu Ethylen und Ethan

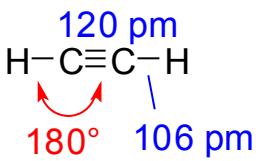


σ-CC-Bindung

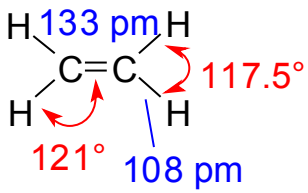


2 π-CC-Bindungen

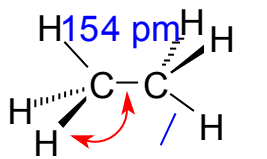
Ethin



Ethen

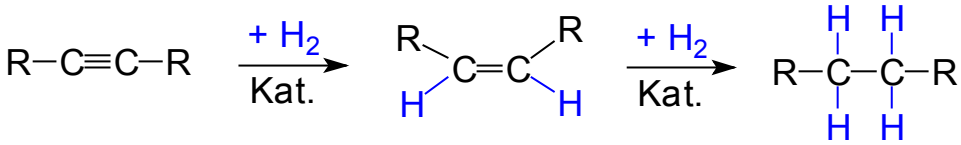


Ethan



Reaktionen der Alkine

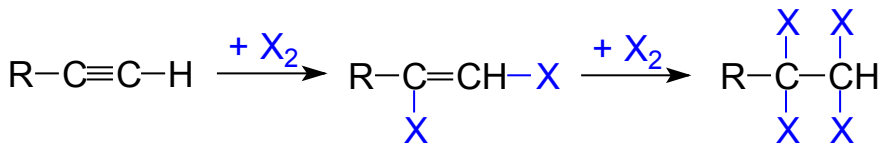
Katalytische Hydrierung:



cis-Alken isolierbar

Alkan

Elektrophile Addition:



Markownikow-Regel gilt