

Die Elemente der IV. Hauptgruppe

1. Die Elemente der IV. Hauptgruppe (C, Si, Ge, Sn, Pb) haben die Valenzelektronen-Konfiguration $n s^2 p^2$.
2. Sie stehen von beiden Seiten des Periodensystems gleichweit entfernt und können daher je nach Reaktionspartner bis zu vier Elektronen abgeben oder aufnehmen. Die Abgabe bzw. Aufnahme von vier Elektronen sollte zu den Kationen E^{4+} bzw. den Anionen E^{4-} führen.
3. Der Energieaufwand für beide Vorgänge ist jedoch sehr hoch, so dass sowohl in den „salzartigen“ Carbiden und Siliciden (Al_4C_3 , Mg_2Si) als auch in Blei(IV)-Verbindungen (PbF_4 , PbO_2) beträchtliche kovalente Bindungsanteile vorliegen.

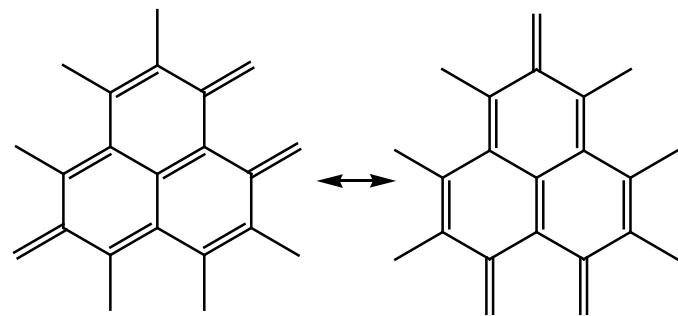
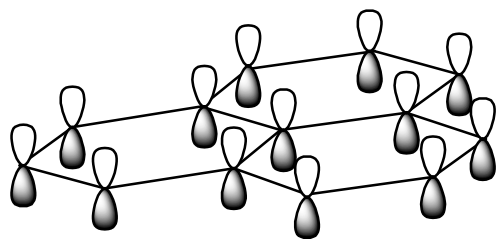
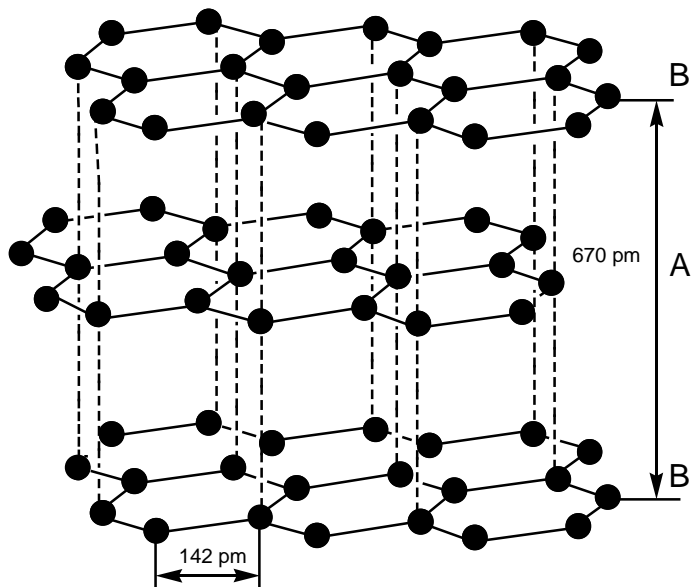
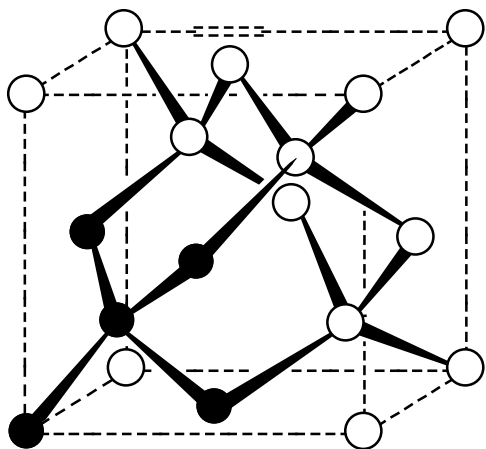
4. C, Si, Ge und Sn zeigen in ihren natürlich vorkommenden Verbindungen die Oxidationsstufe +4, Pb die Oxidationsstufe +2.
5. Kohlenstoff ist ein typisches Nichtmetall und Blei ein typisches Metall. Unterschiede in der chemischen Bindung bedingen die unterschiedlichen Eigenschaften wie Härte und Sprödigkeit bei C, Si und Ge, Duktilität beim Sn und die metallischen Eigenschaften beim Pb.
6. Die Hydroxyverbindungen von C, Si und Ge besitzen sauren Charakter, $\text{Sn}(\text{OH})_2$ ist amphoter und $\text{Pb}(\text{OH})_2$ überwiegend basisch. Während die Polarisierung von C-H-Bindungen mit $\text{C}^{\delta-}\text{H}^{\delta+}$ zu beschreiben ist, sind die übrigen Element-Wasserstoff-Verbindungen als Hydride $\text{E}^{\delta+}\text{H}^{\delta-}$ zu betrachten.

C(Diamant)

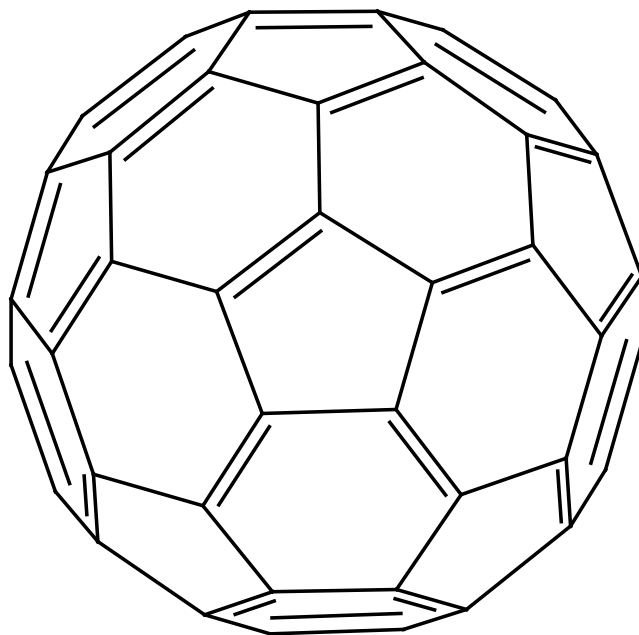


C(Graphit)

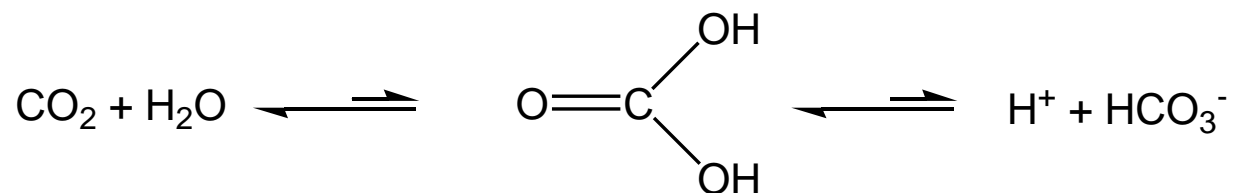
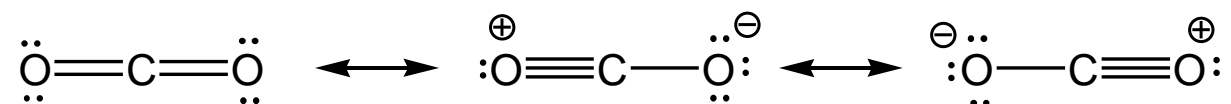
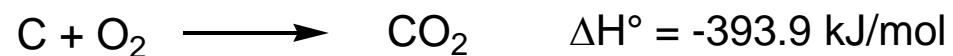
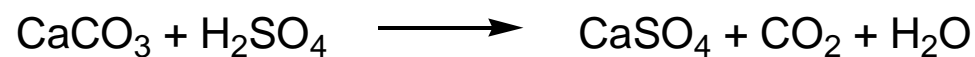
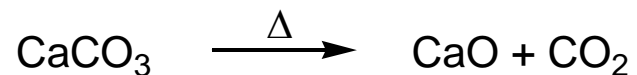
$\Delta_r H^\circ = - 1.89 \text{ kJ/mol}$



Fulleren C₆₀

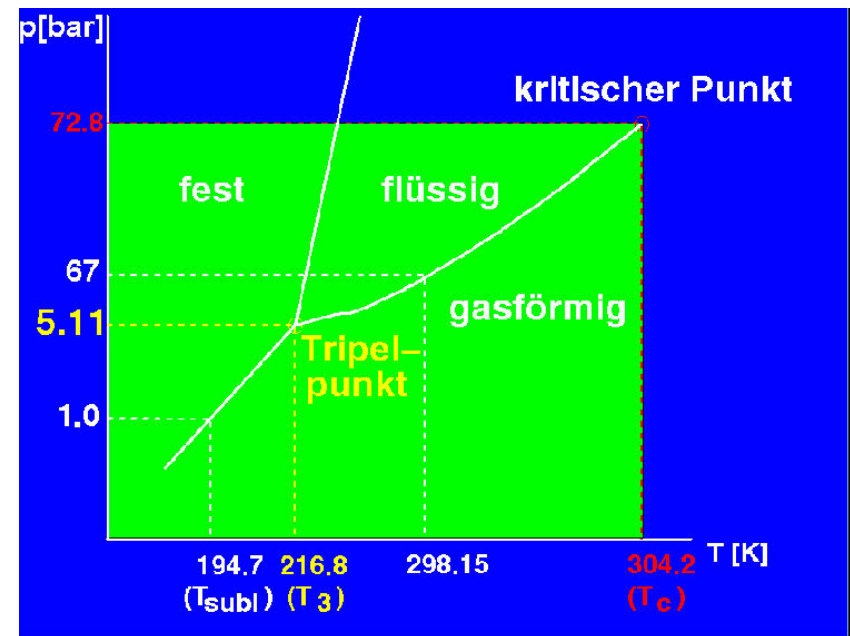
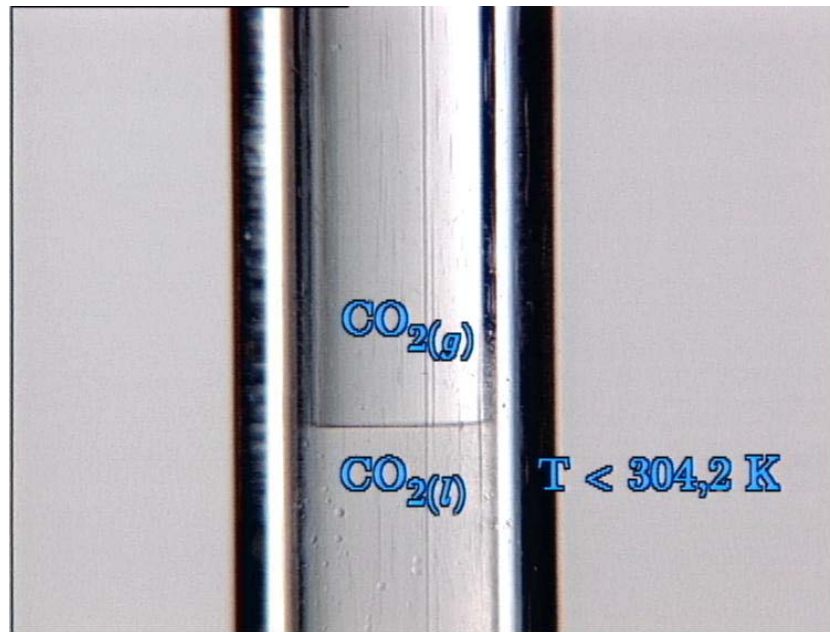


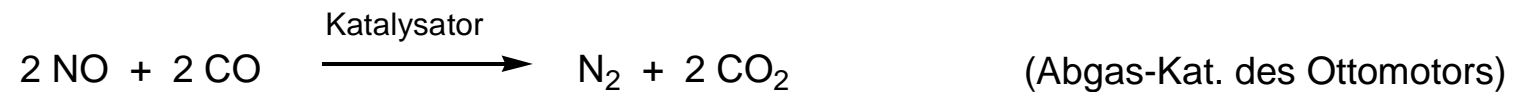
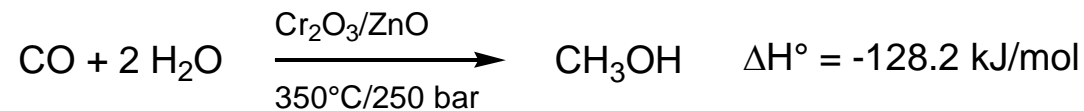
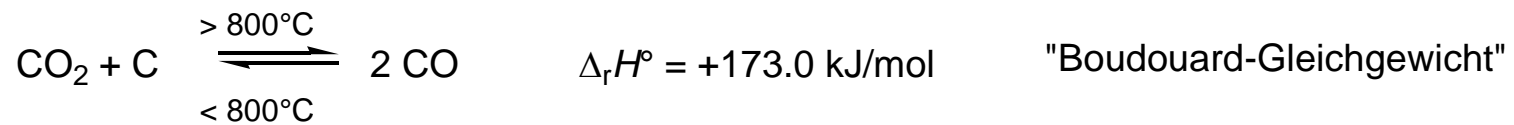
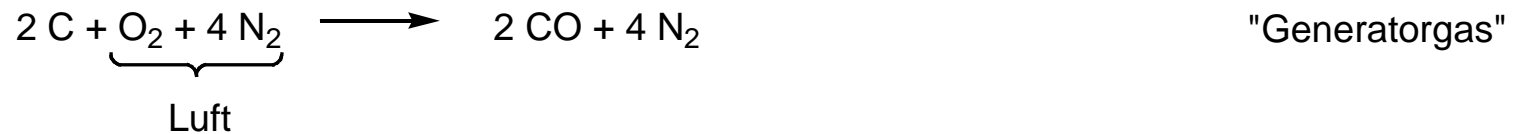
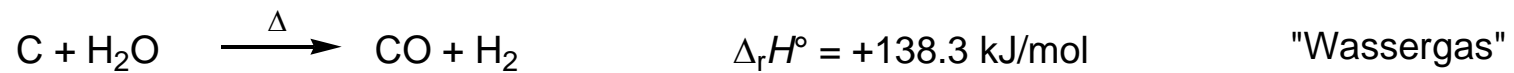
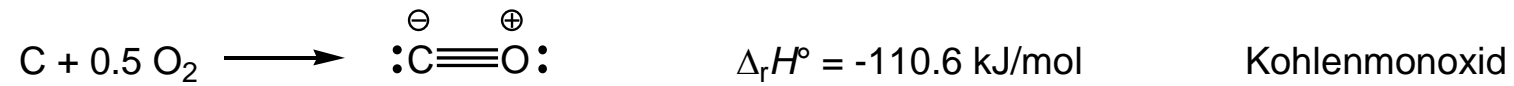
Kohlendioxid und Kohlensäure



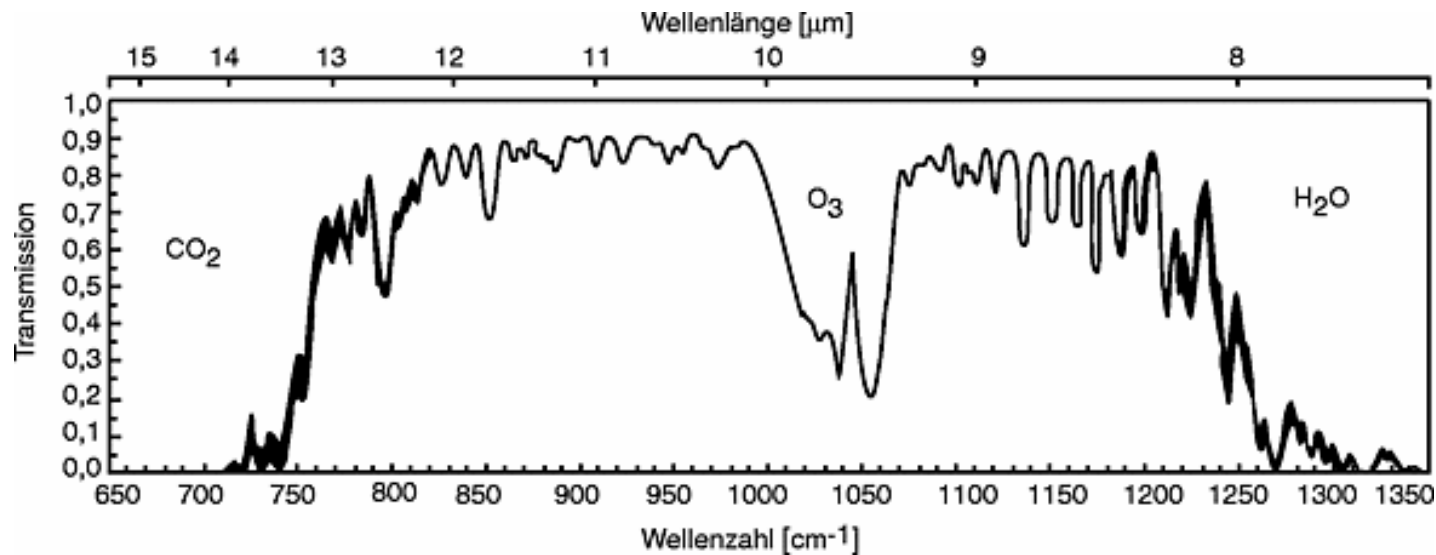
$\text{pK}_{\text{a}1} : 6.35$

Kritische Temperatur des CO₂





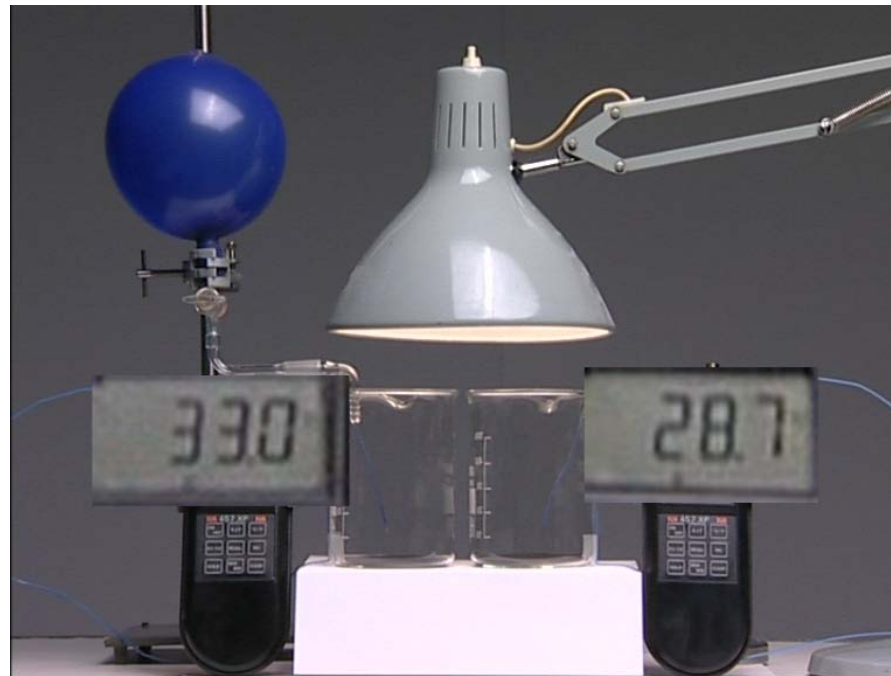
Treibhauseffekt



“Atmosphärisches Fenster” für die direkte Wärmeabstrahlung von der Erdoberfläche: 8-13 μm.

Ozon, Methan, Distickstoffmonoxid und Chlorfluorkohlenwasserstoffe absorbieren hier und gelten als "Treibhausgase".

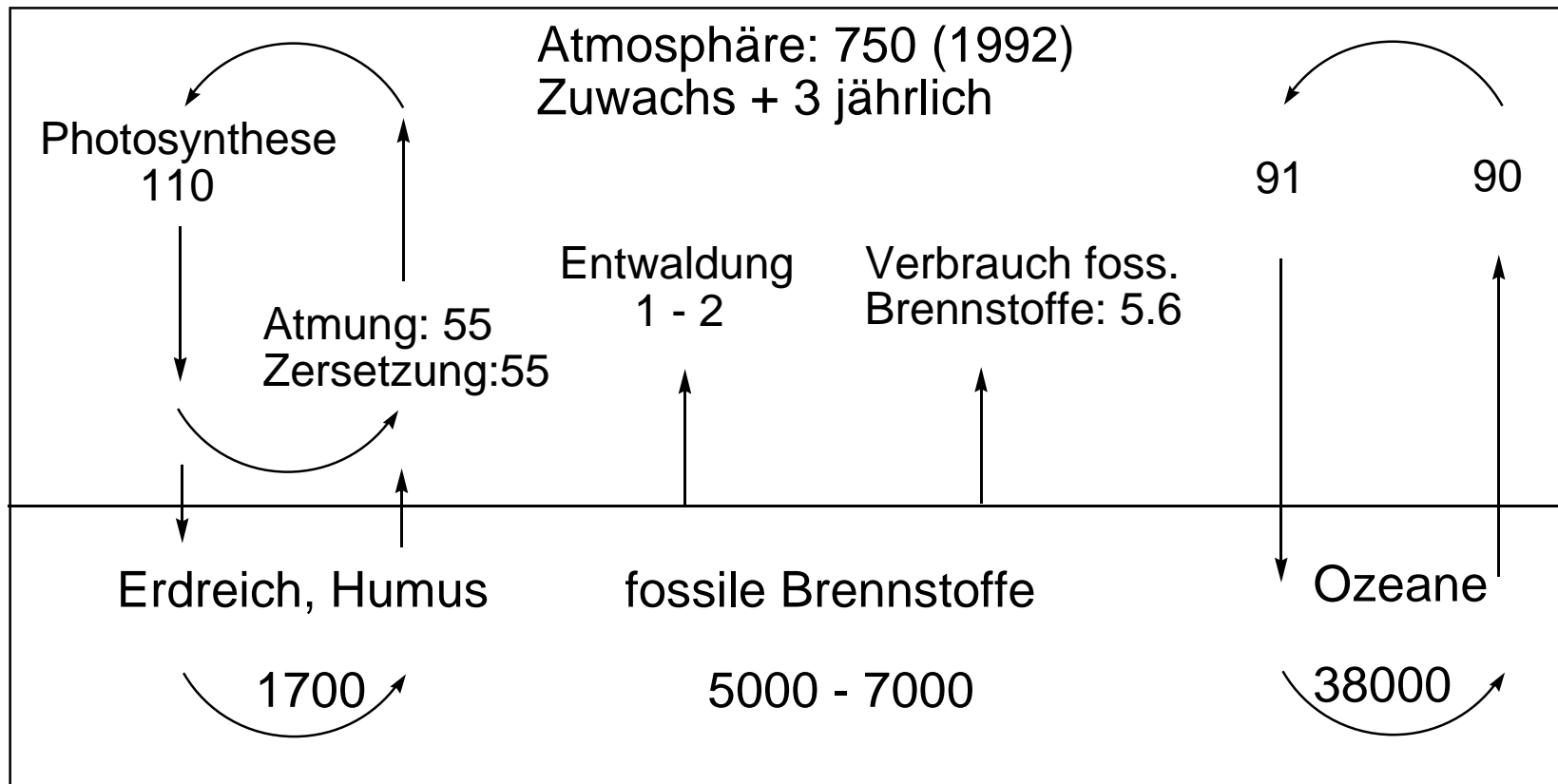
Modellversuch zum Treibhauseffekt



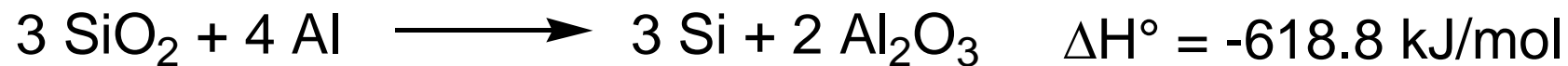
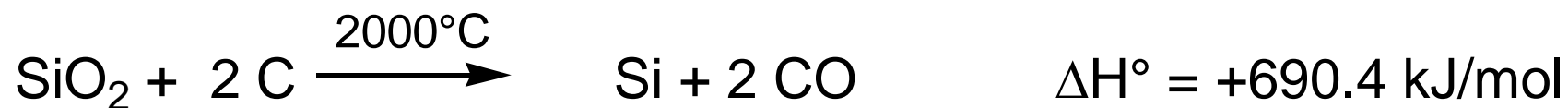
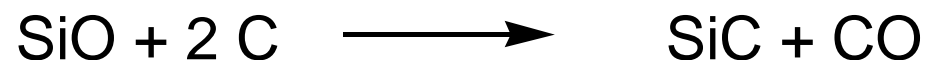
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Kohlenstoffkreislauf

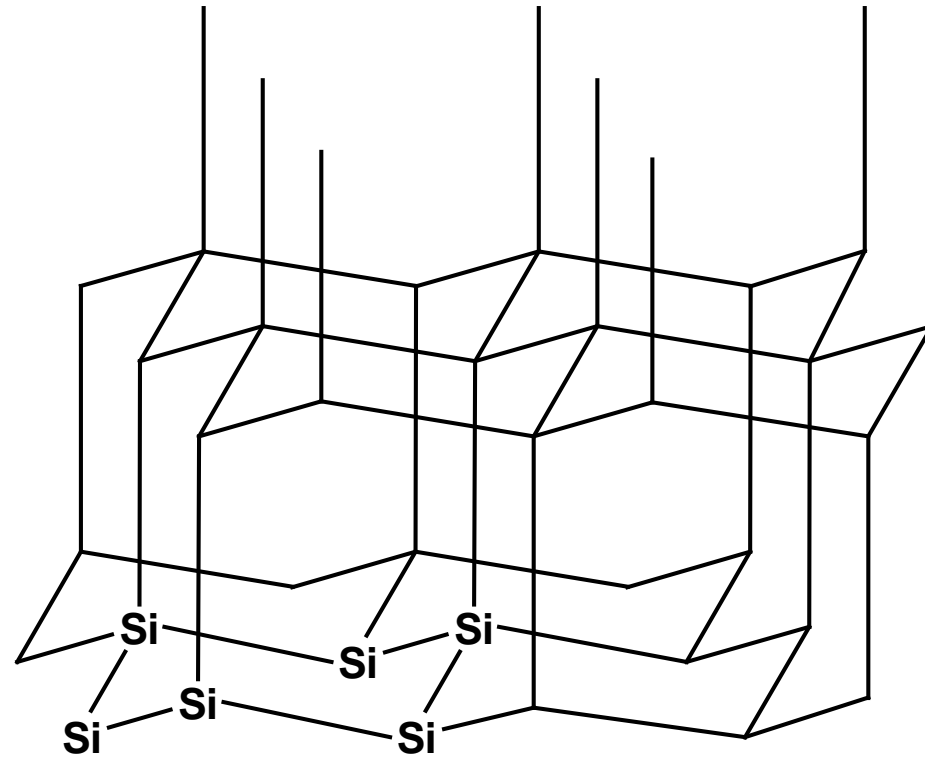
Stoff-Fluss in Mrd. Tonnen Kohlenstoff



Silicium

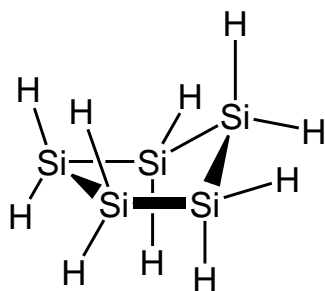
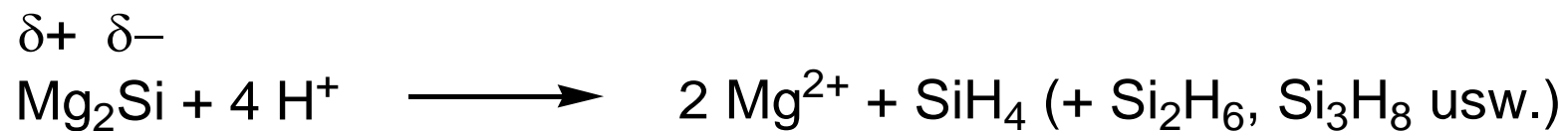


α -Silicium

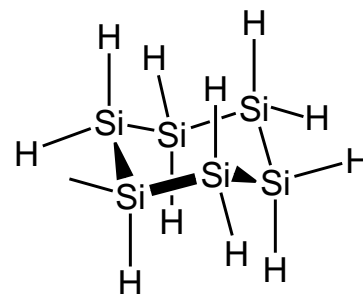


Diamantstruktur
Sesselkonformation

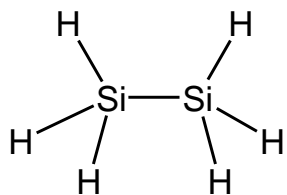
Silane



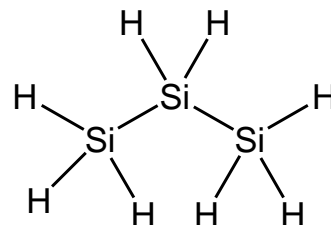
Cyclopentasilan Si_5H_{10}



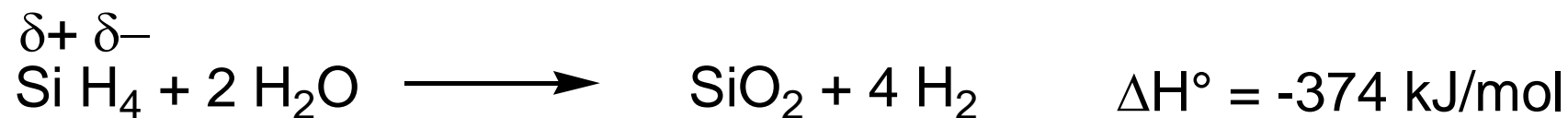
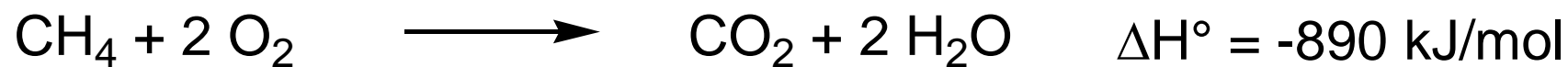
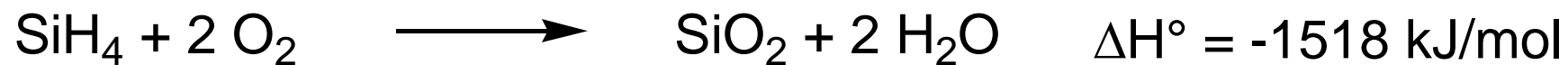
Cyclohexasilan Si_6H_{12}



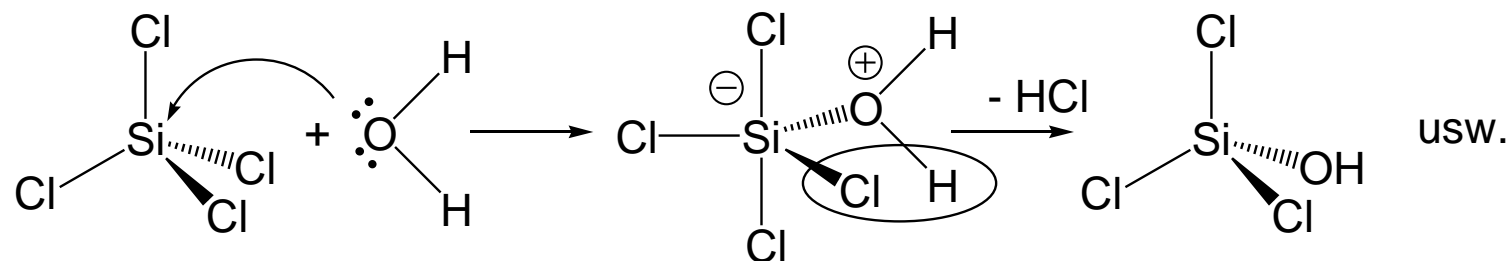
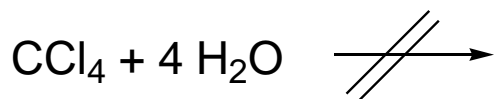
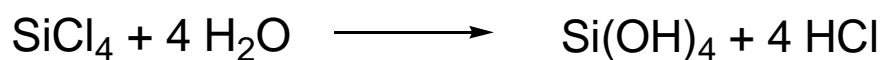
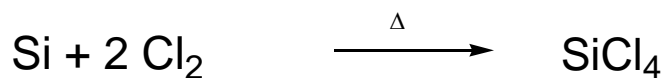
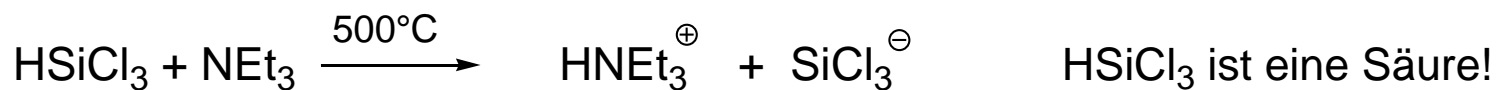
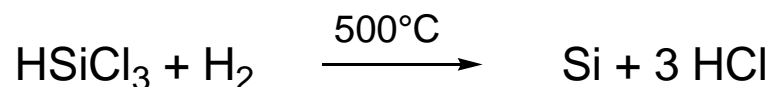
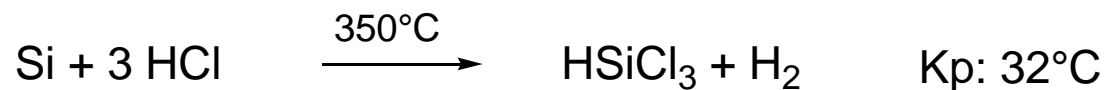
Disilan Si_2H_6



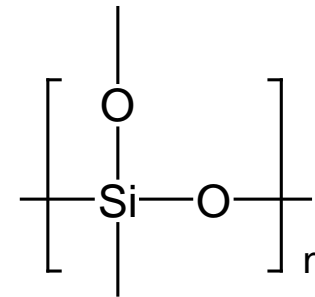
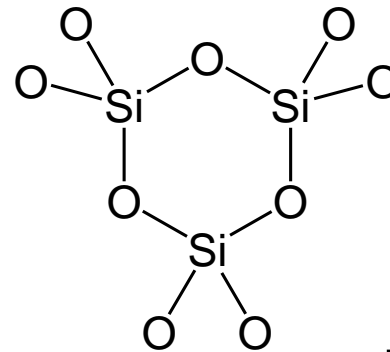
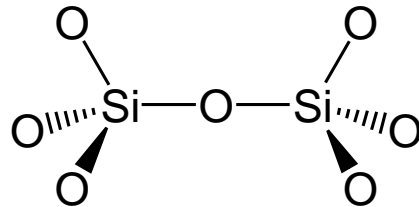
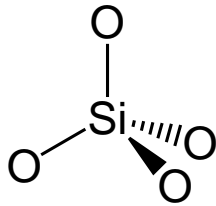
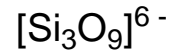
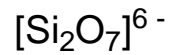
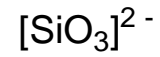
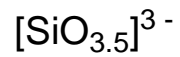
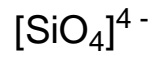
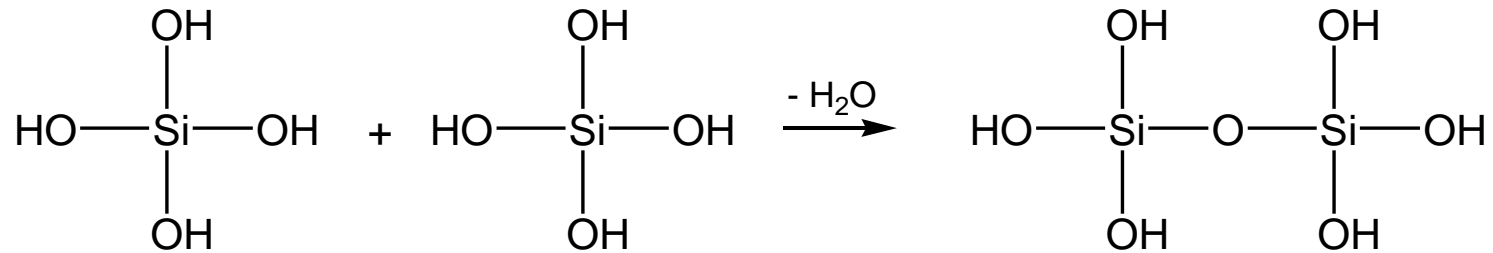
Trisilan Si_3H_8



Chlorsilane



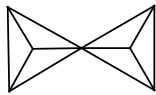
Kieselsäuren und Silikate



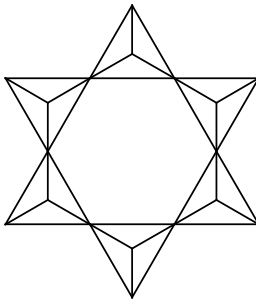
Silikatstrukturen



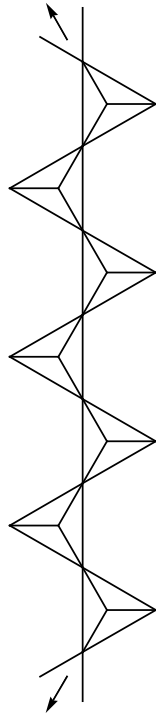
Insel
 SiO_4^{4-}



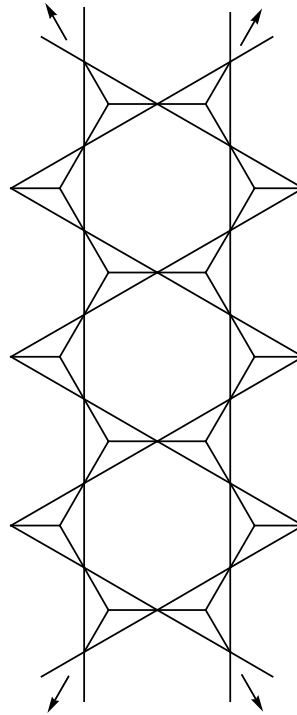
Gruppe
 $\text{Si}_2\text{O}_7^{6-}$



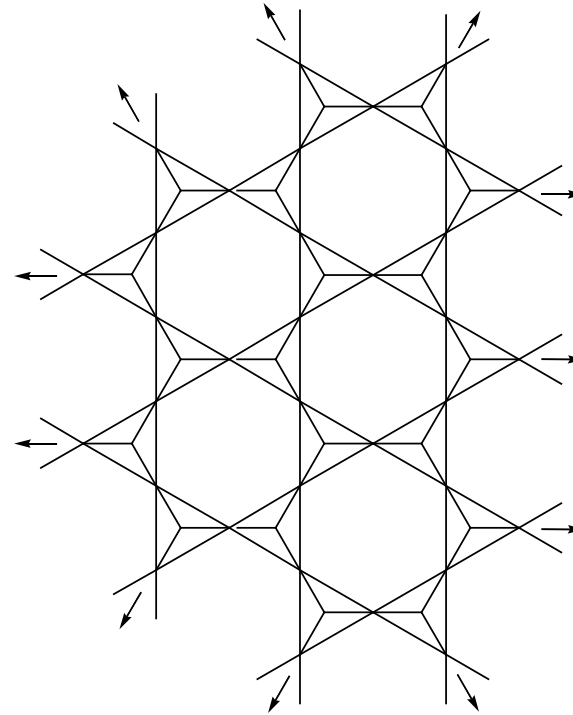
Ring
 $(\text{SiO}_3^{2-})_6$



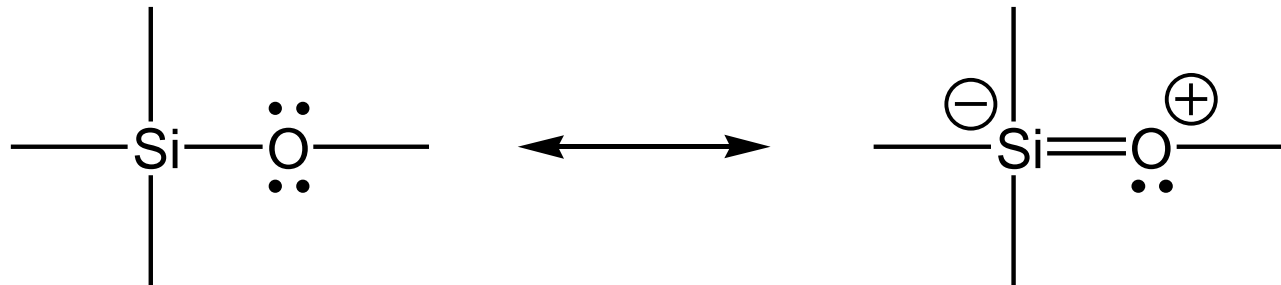
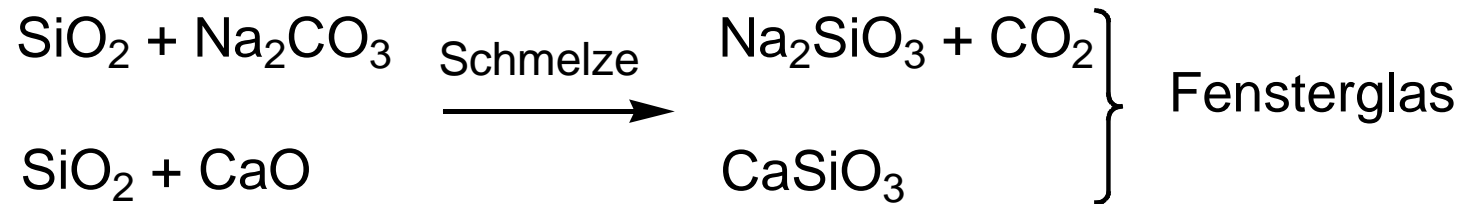
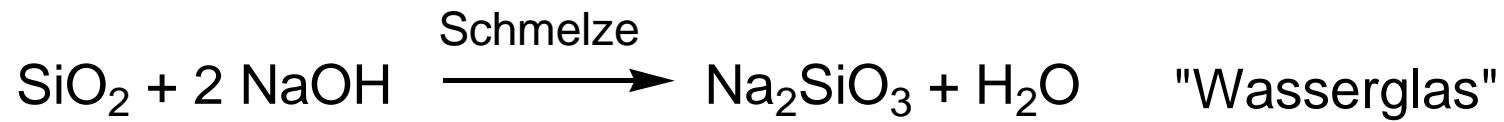
Kette
 $(\text{Si}_2\text{O}_6^{4-})_n$



Band
 $(\text{Si}_4\text{O}_{11}^{6-})_n$



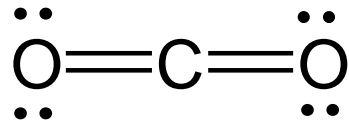
Blatt
 $(\text{Si}_2\text{O}_5^{2-})_n$



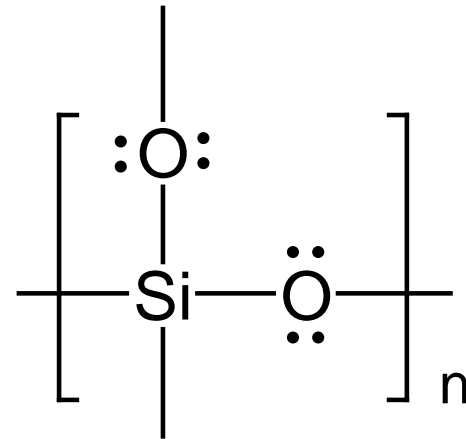
Der Si-O-Si-Bindungswinkel beträgt 145-150° (nicht 109.5°)!

Strukturvergleich CO₂ / SiO₂

p_π-p_π-Doppelbindungen

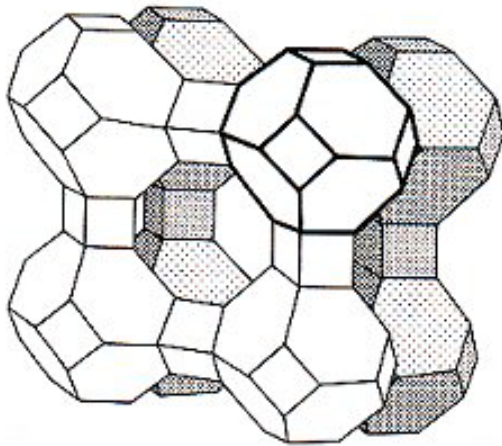


gasförmig

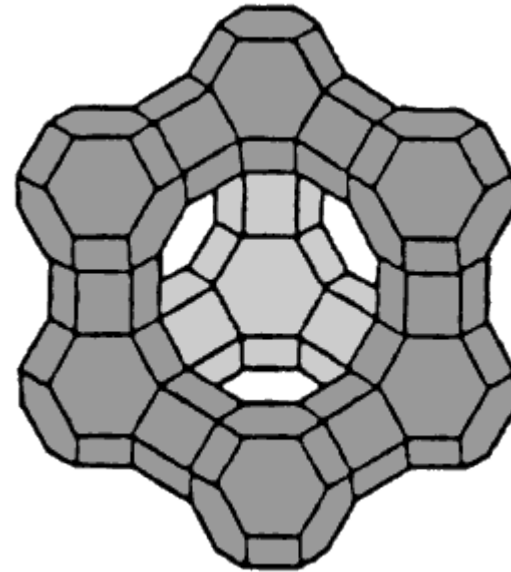


kristallin

Zeolithe



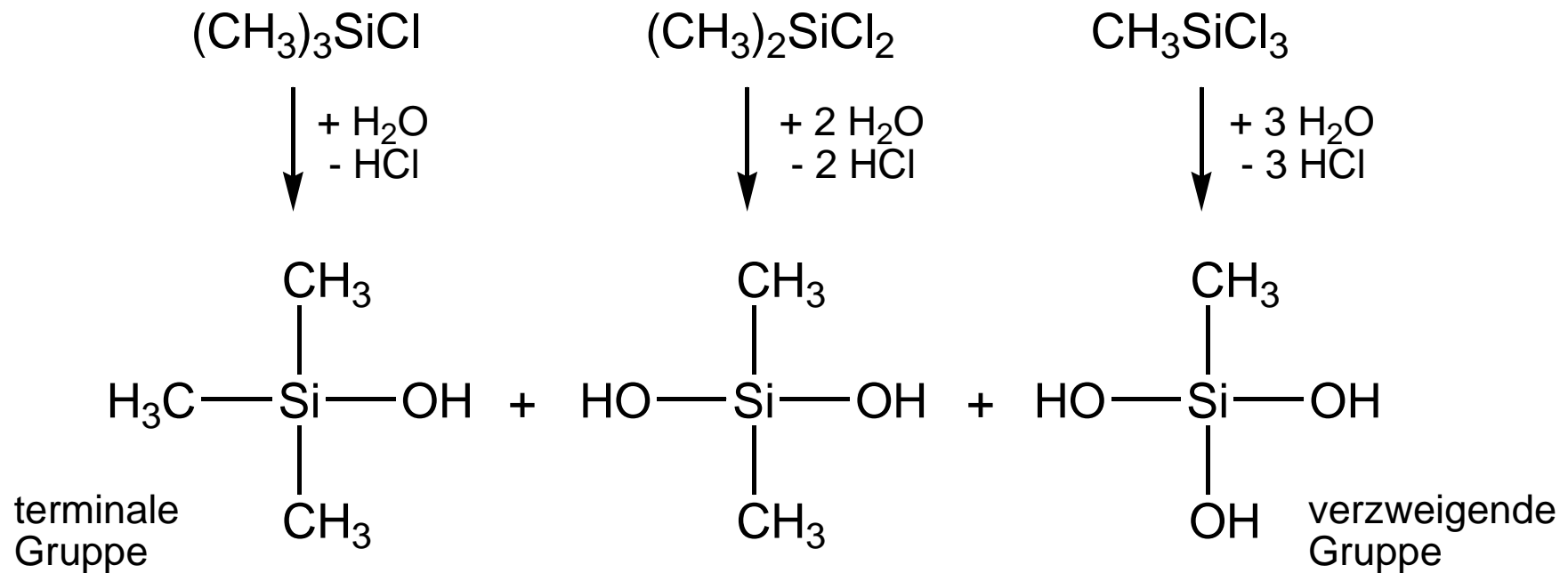
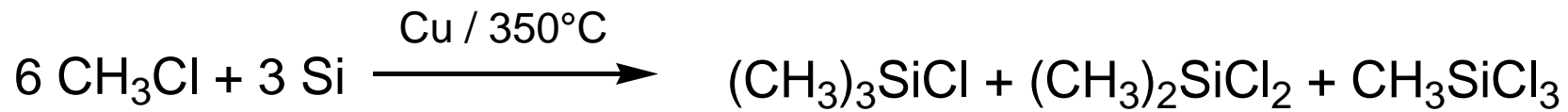
Zeolith A

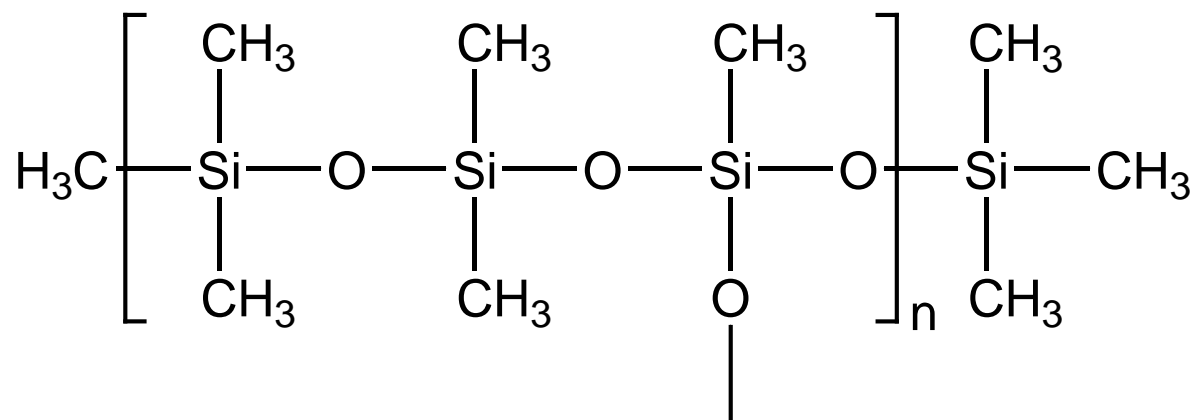
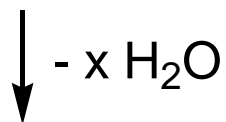
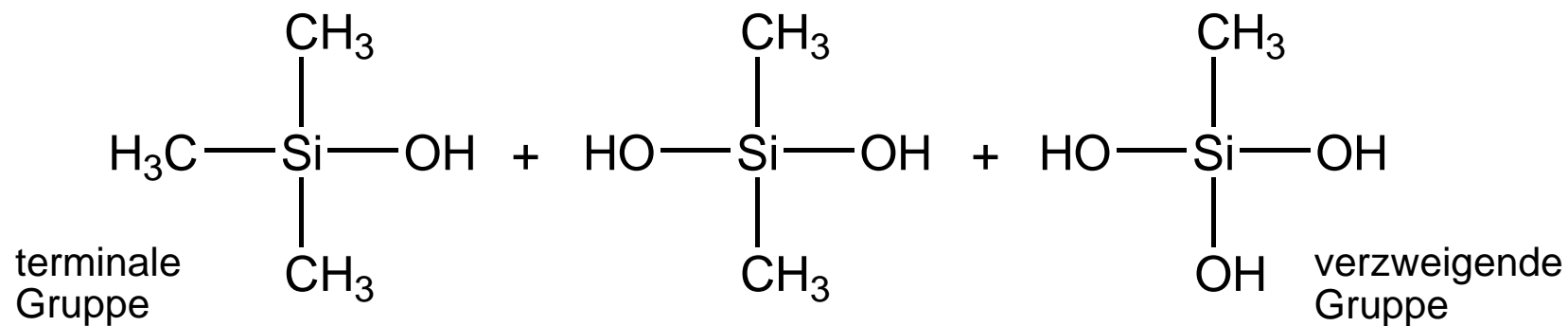


Zeolith X (Faujasit)



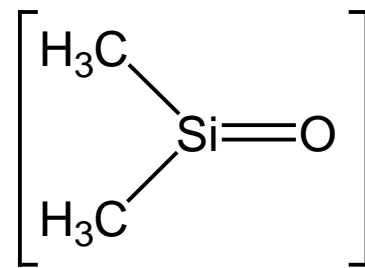
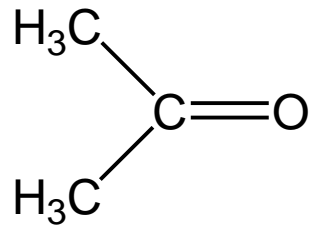
Müller-Rochow-Synthese



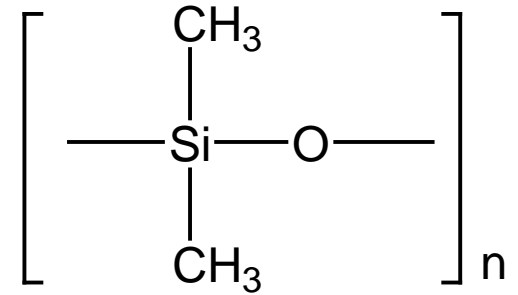


"Silicone"

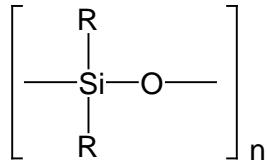
Strukturvergleich Ketone / Silicone



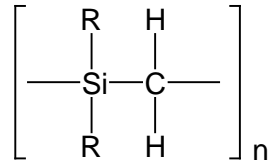
instabil



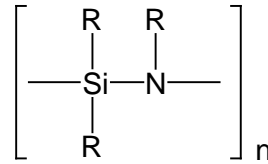
Siliciumorganische Polymere



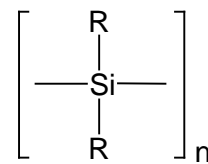
Silicone



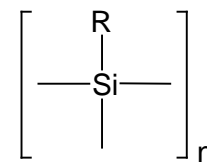
Polycarbosilane



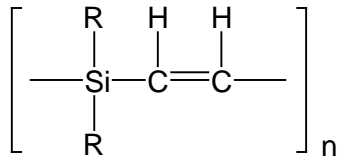
Polysilazane



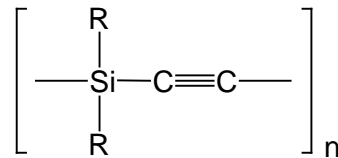
Polysilane



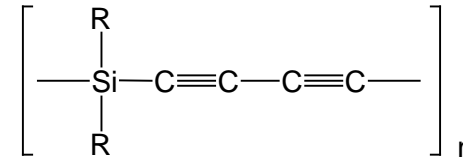
Polysilene



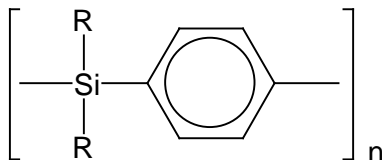
Polysilylenalkene



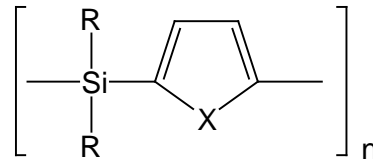
Polysilylenalkine



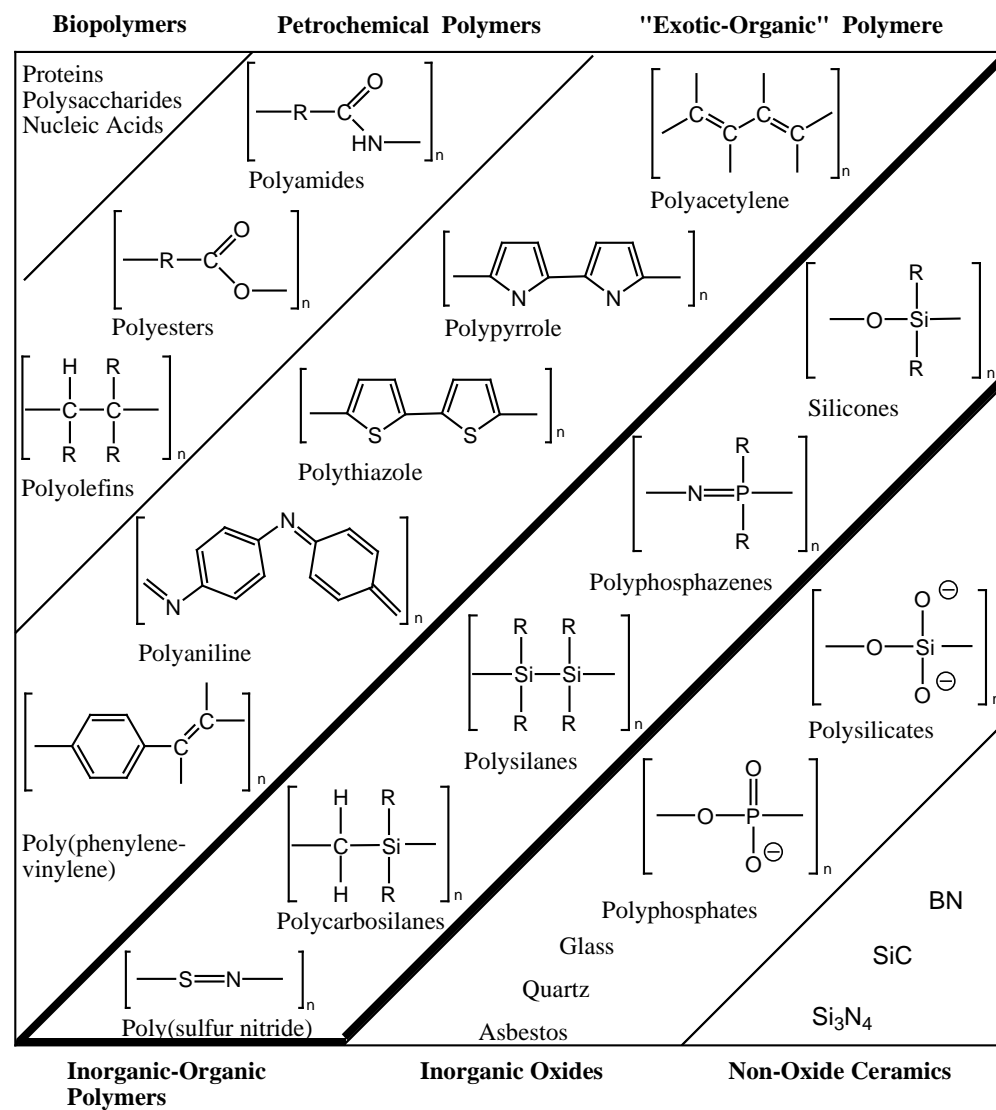
Polysilylenbutadiine



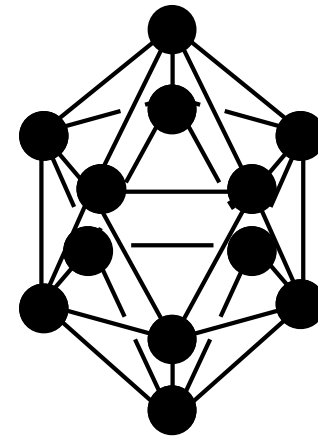
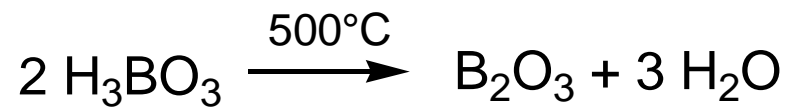
Polysilylenarene



Polysilylenheteroarene

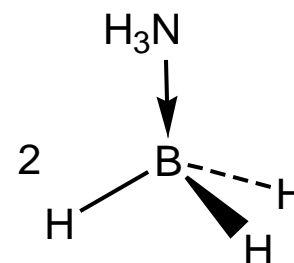
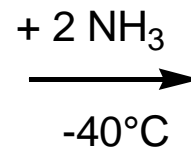
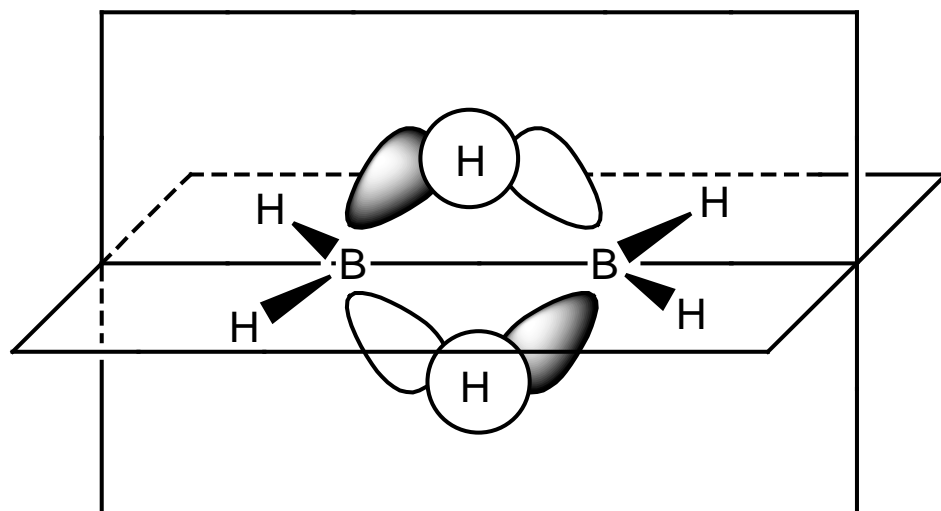
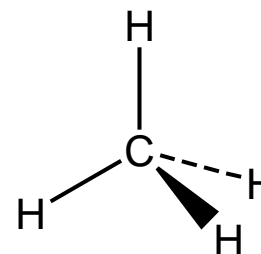
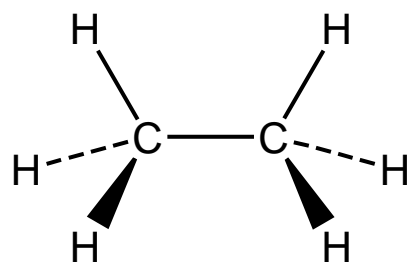


Herstellung von Bor

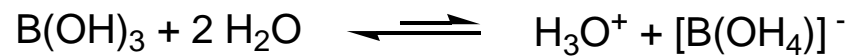


Ikosaeder

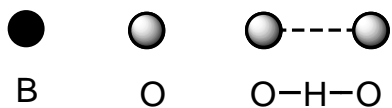
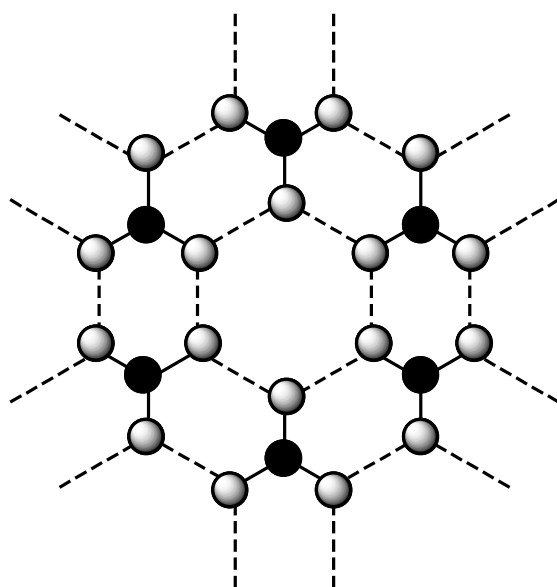
Strukturvergleich B_2H_6 / C_2H_6



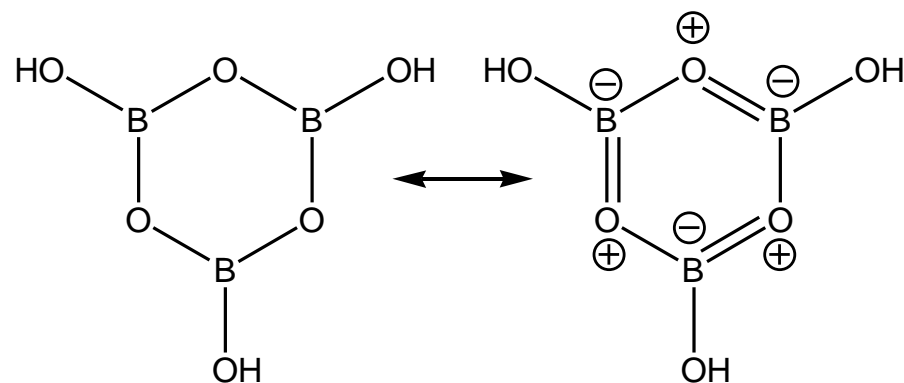
Borsäure



Lewis-Säure
keine Brönsted-Säure



Orthoborsäure

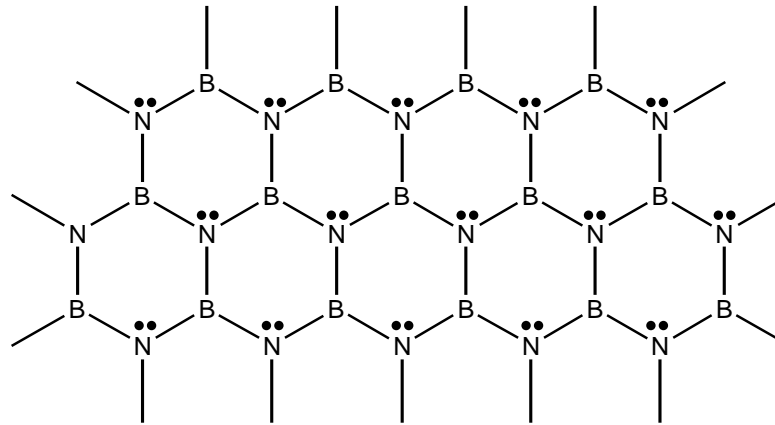


Metaborsäure

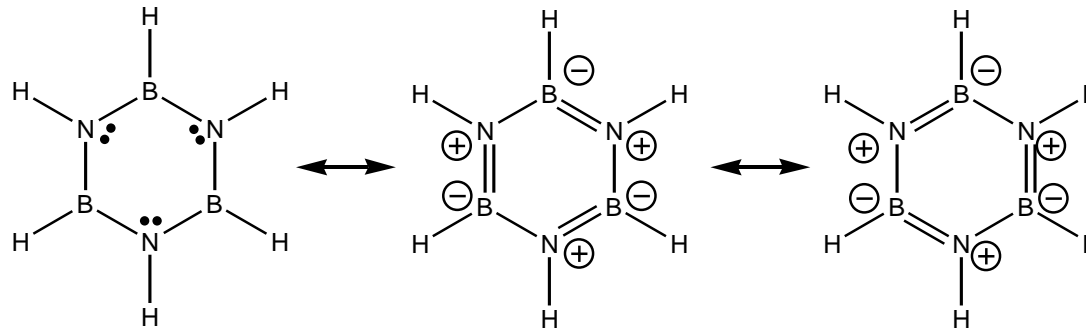
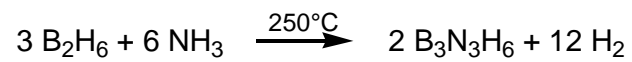
"Boroxin"-Struktur

(Die freien Elektronenpaare am Sauerstoff wurden in beiden Formeln weggelassen.)

Bornitrid und Borazin



Ausschnitt aus
einer Schicht des
hexagonalen $(\text{BN})_x$



Bindungslängenvergleich: B-N (im Borazin): 143.6 pm; C-C (im Benzen): 140 pm