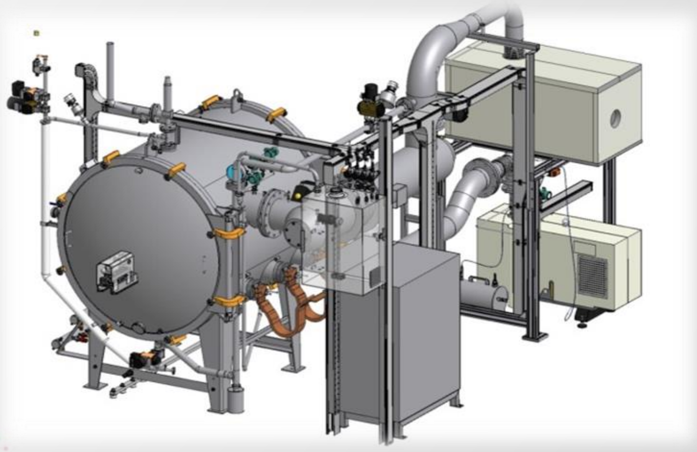
Solutions for metal cutting

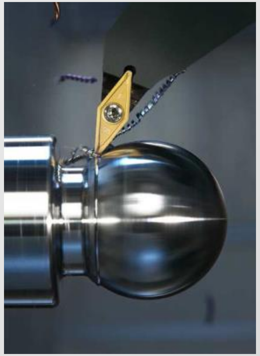
Applications of thermodynamic calculations

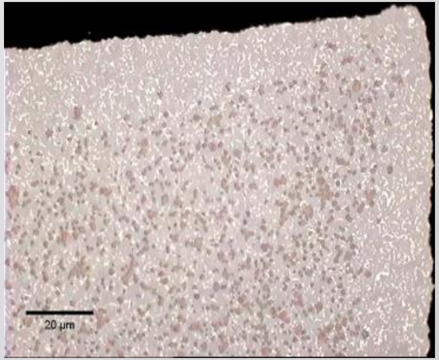
Henrik Strandlund

Applications

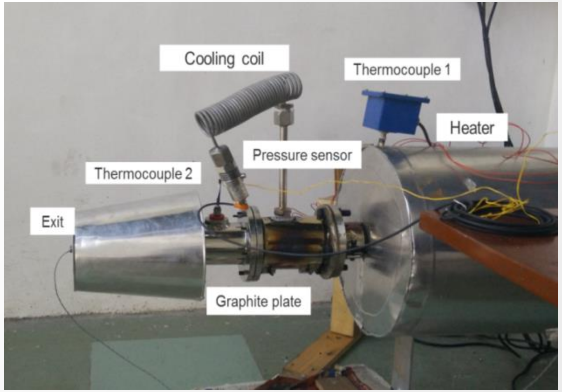
- Machining dynamics
- Metal cutting
- ***Wear of inserts***
- ***Manufacturing processes***
- Solid mechanics
- ***Mechanical properties***
- ***Thermodynamic properites***
- ***Microstructure in materials***
- ***Defects in materials***

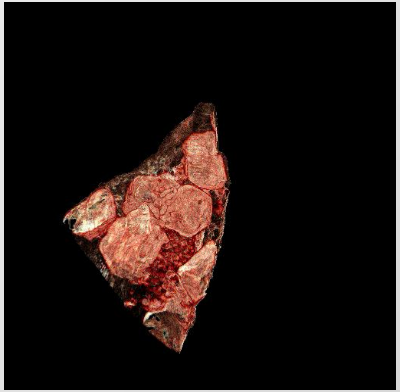


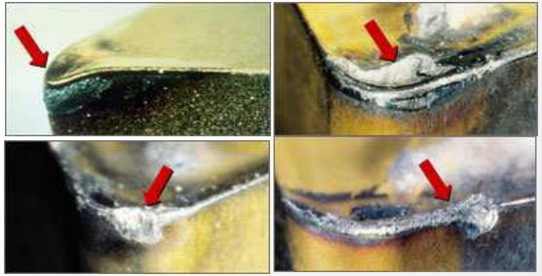


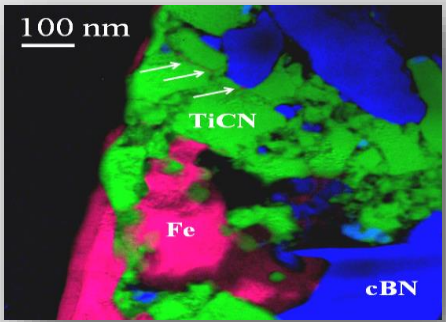


Generating input data and verification of results





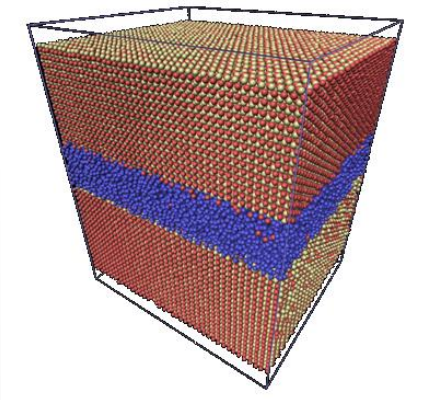


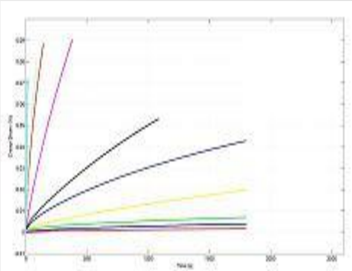


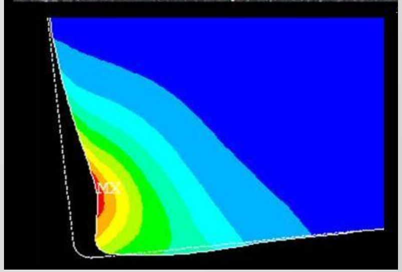
Wear of inserts

Predicting plastic deformation

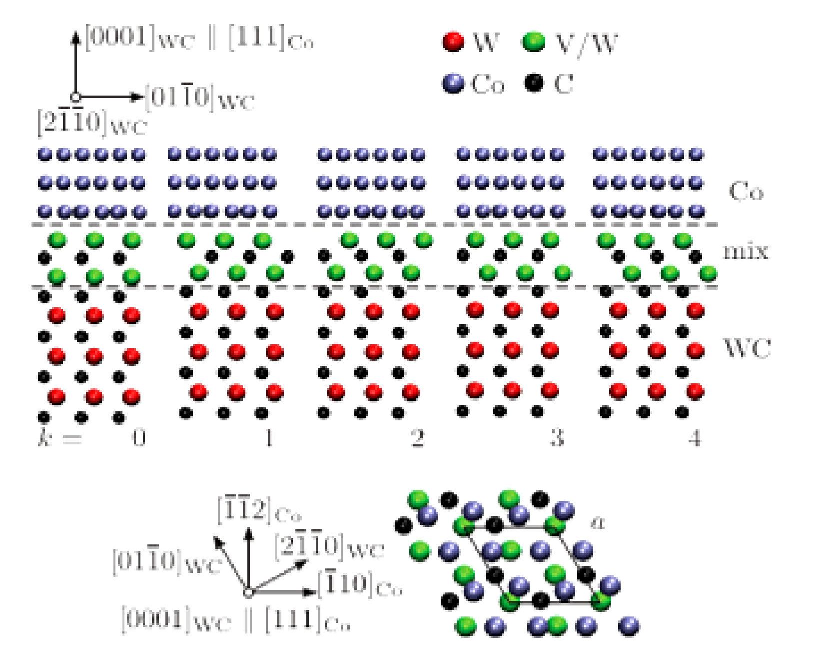
Fundamental atomistic simulations, thermodynamic calculations and measurements to generate input to models

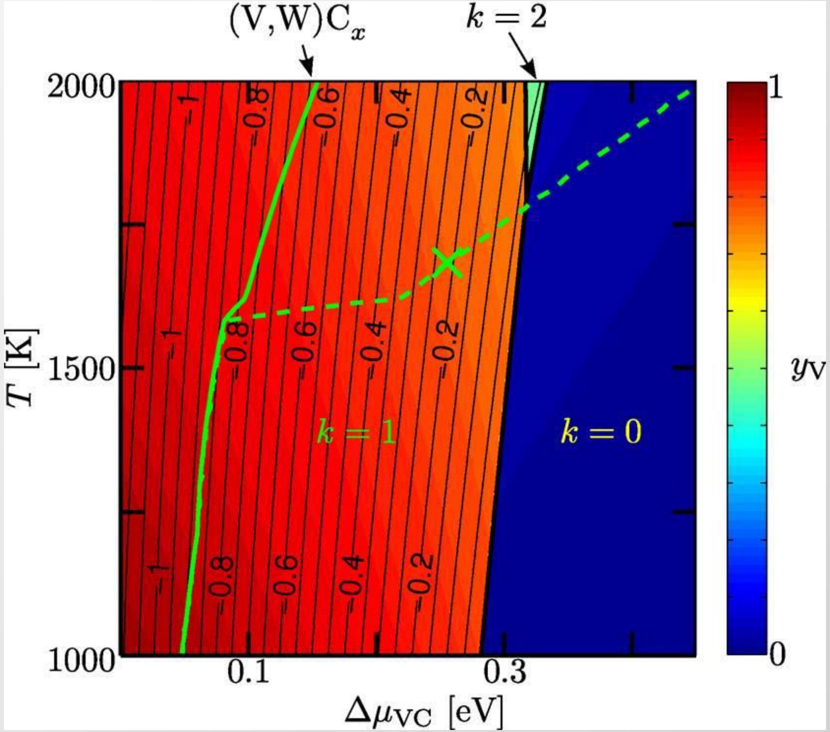






Thermodynamics properties and defects





S. A. E. Johansson and G. Wahnström, Phys Rev B 86, 035403 (2012)

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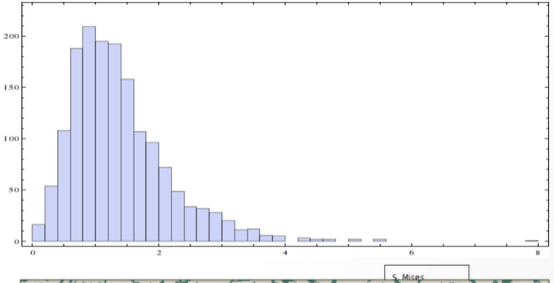
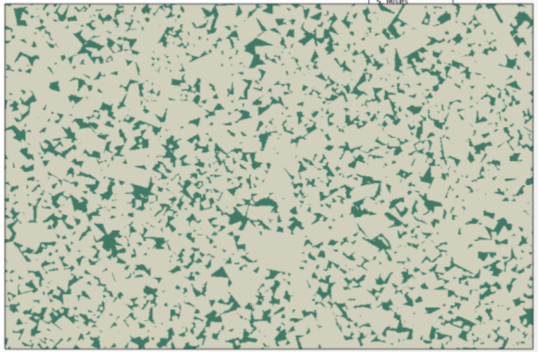
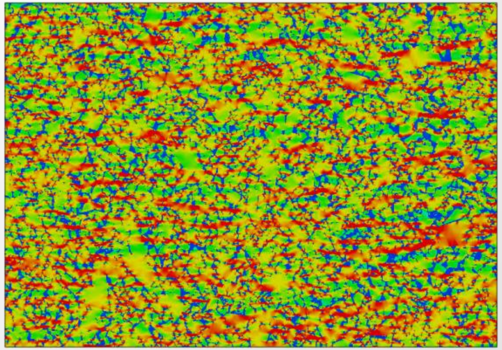
Microstructure in materials and mechanical properties

Microstructural FEM of plastic deformation

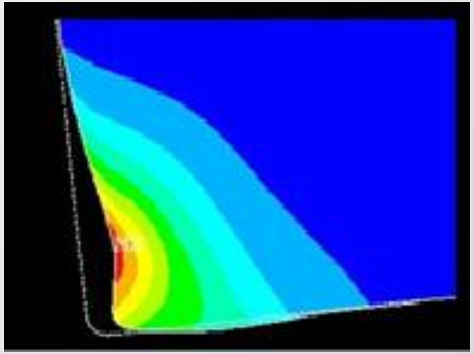




Microstructure before Deformation (SEM image)



Simulated deformed microstructure



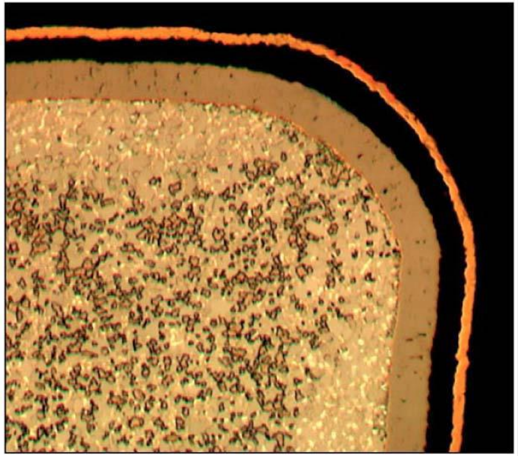
Simulated macroscopic deformation

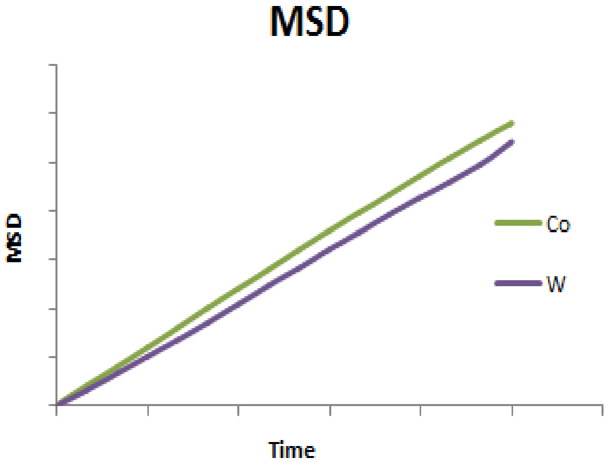
Microstructure in materials and mechanical properties

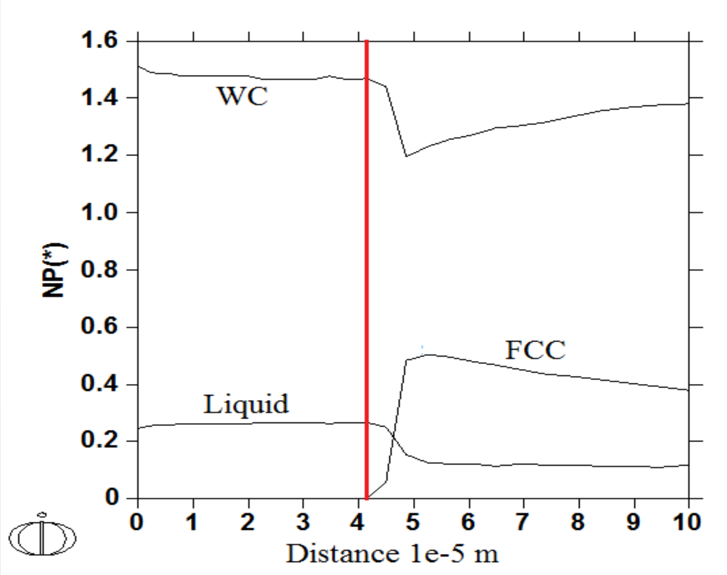
Gradient formation in cemented carbides

Atomistic mobilities in liquid state, Ab-inito MD simulations

Depth of the gradient



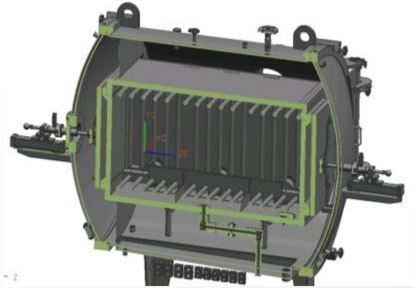




M Wahlbrül, Master Thesis, 2014

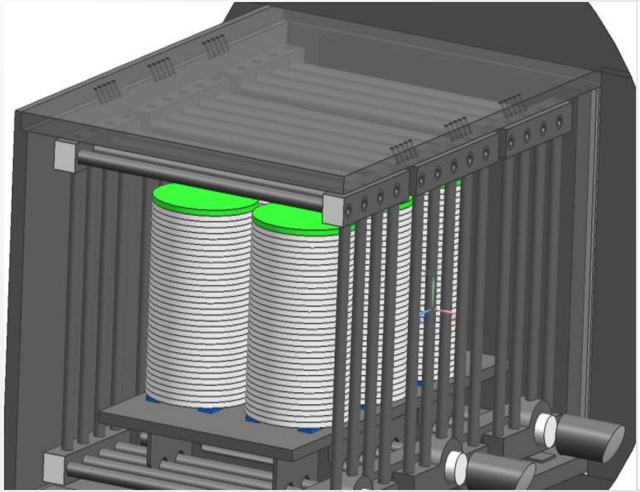
Properties of manufacturing processes

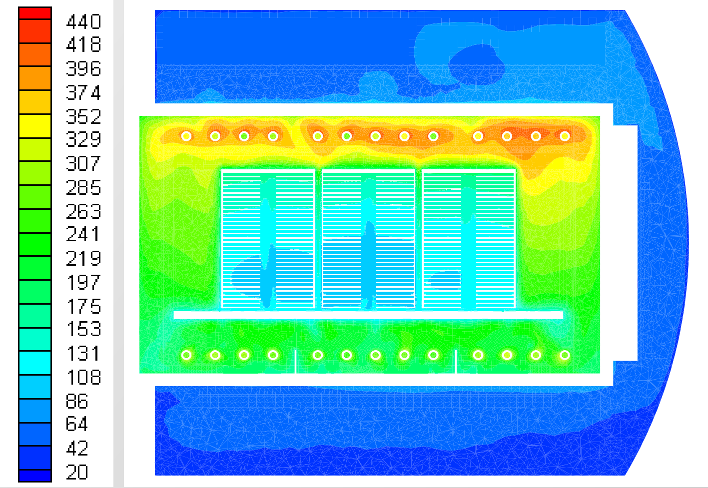
Otimization of sintering processes and furnaces



Optimizing equipment and processes by simulating and studying gas and temperature distribution

Simulations of debinding





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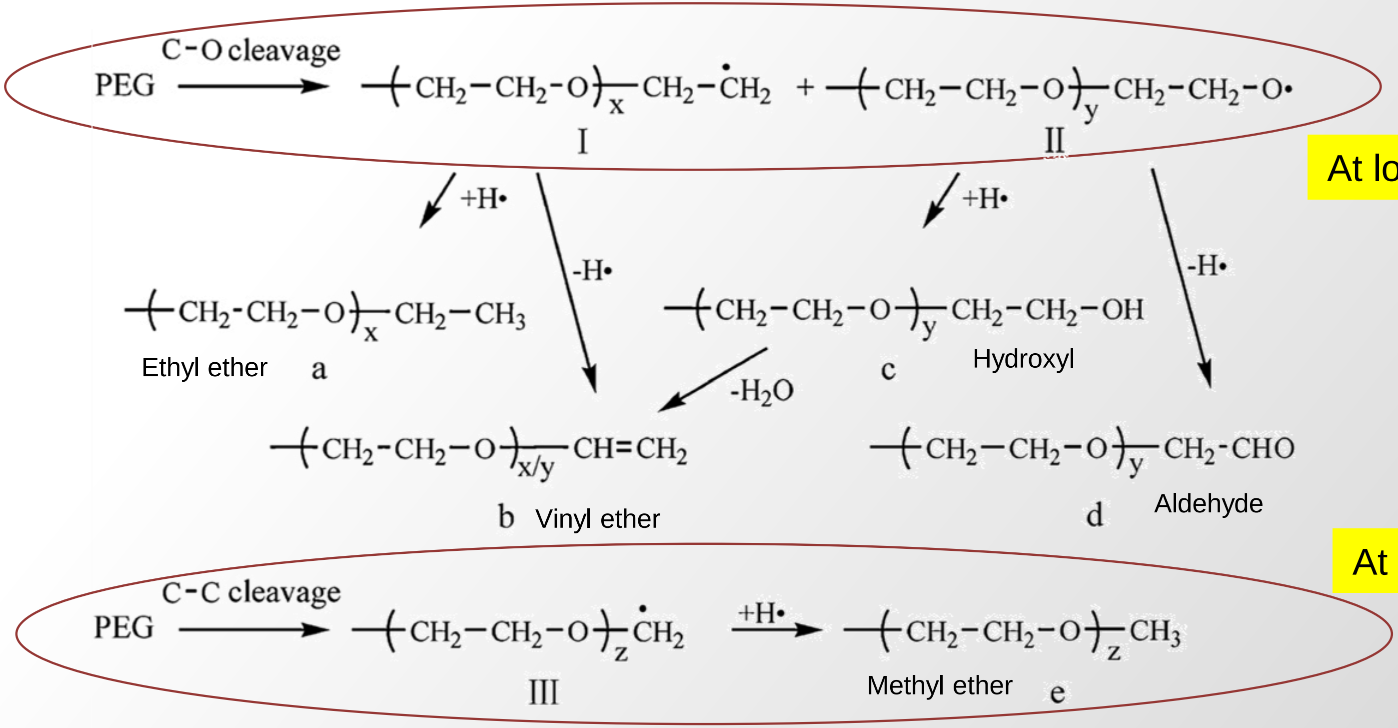
Decomposition of the binder (PEG)



Scheme 1. The decomposition pathway of PEG.

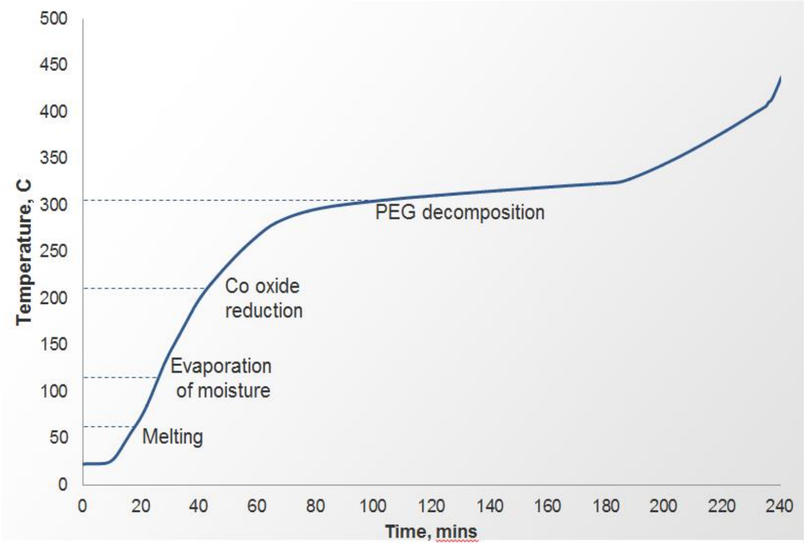
At low Temp (Onset of reaction)

At high Temp (above 200 ^{0}C)

Decomposition of the binder (PEG)

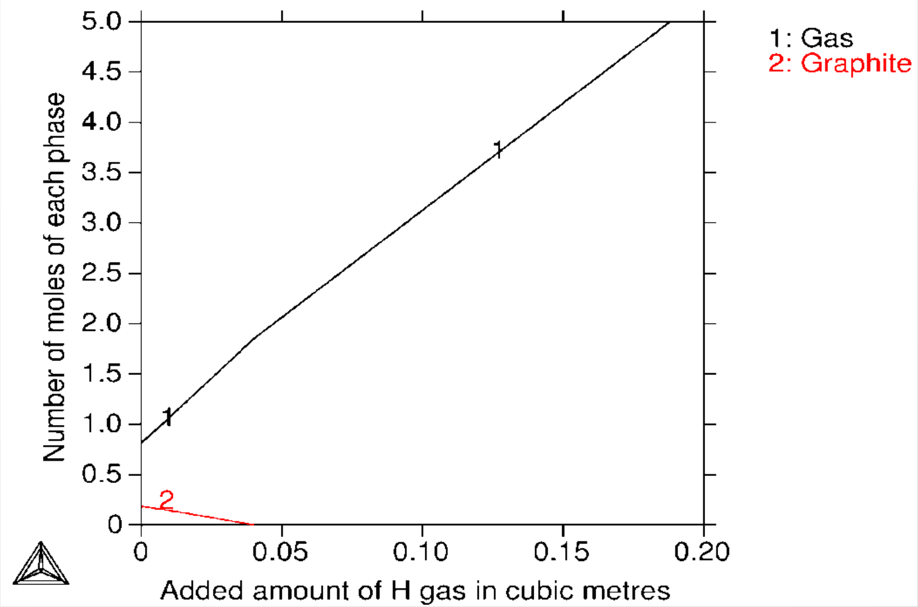
Group name	Product series	Molecular weight	Comp (%)
A	CH_3-(O-CH_2-CH_2)$_n$-O-CH_2-CH_2-OH	120-516	0.5-2.5
B	CH_3-(O-CH_2-CH_2)$_n$-O-CH_3	90-354	
C	HO-CH_2-CH_2-(O-CH_2-CH_2)$_n$-OH	102-546	
D	OHC-CH_2-(O-CH_2-CH_2)$_n$-OH	100-544	
E	CH_3-CH_2-(O-CH_2-CH_2)$_n$-O-CH_3	100-408	1-3.1
F	CH_2=CH-(O-CH_2-CH_2)$_n$-O-CH_3	102-410	
G	CH_3-CH_2-(O-CH_2-CH_2)$_n$-O-CH_2-CH_2-OH	134-486	2.2-5.6
H	CH_2=CH-(O-CH_2-CH_2)$_n$-O-CH_2-CH_2-OH	132-440	
I	CH_3-CH_2-(O-CH_2-CH_2)$_n$-O-CH_2-CH_3	108-558	1.3-2.2
J	CH_2=CH-(O-CH_2-CH_2)$_n$-O-CH_2-CH_3	106-384	
K	OHC-CH_2-(O-CH_2-CH_2)$_n$-O-CH_3	108-382	
L	OHC-CH_2-(O-CH_2-CH_2)$_n$-O-CH_2-CH_3	132-528	0.5-0.7
M	CH_2=CH-(O-CH_2-CH_2)$_n$-O-CH=CH_2	104-378	
N	OHC-CH_2-(O-CH_2-CH_2)$_n$-O-CH=CH_2	130-394	
O	OHC-CH_2-(O-CH_2-CH_2)$_n$-O-CH_2-CHO	146-410	

Modeling debinding in cemented carbides



T=300°C, H_2-rich atmosphere,

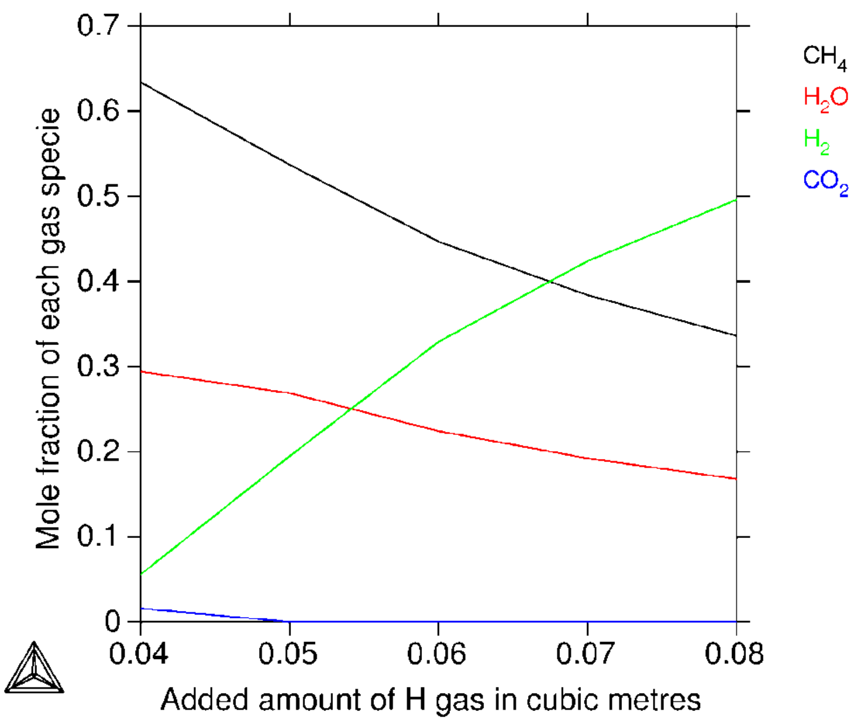
Thermo-Calc + SSUB3 database

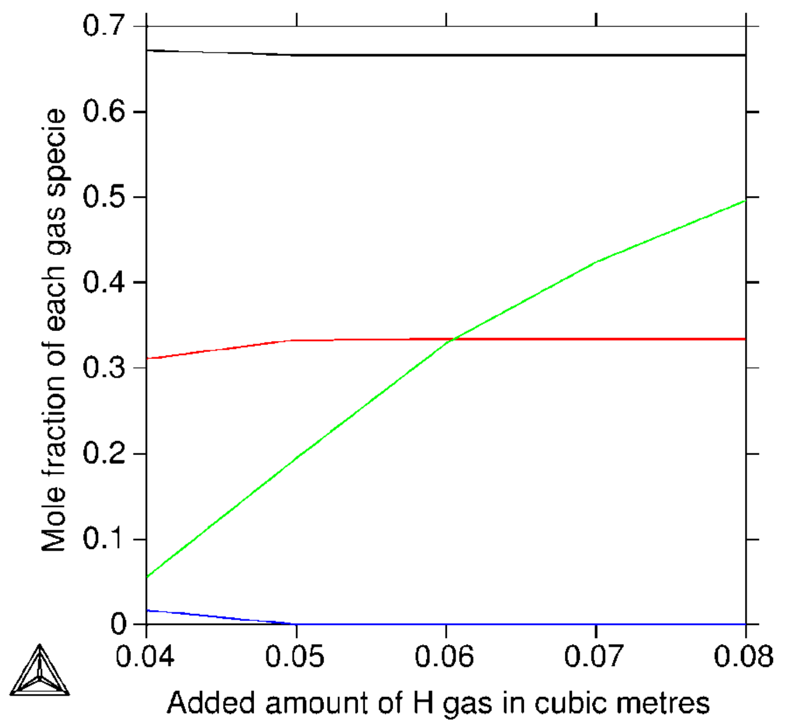


Large amount of H2 gas needed to avoid condensation of graphite!

What do we form instead?

Mostly methane and water.





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