

High temperature corrosion during gasification of biomass and waste

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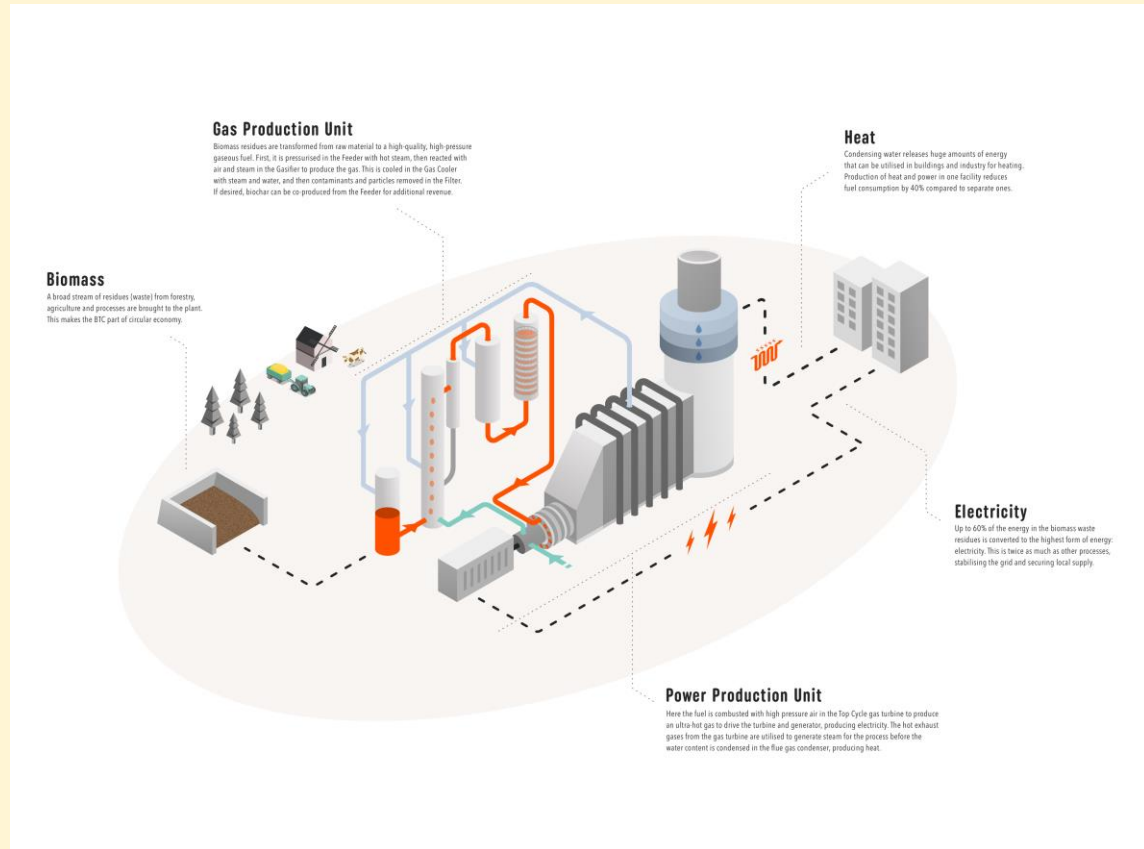
Background - Gasification

- Use for heat and power production
- Use for producing synthesis gas (CO/H₂)



The technology by Phoenix Biopower

- Use for heat and power production
- High-pressure steam treatment and gasification of biomass
- Combustion in a gas turbine for power generation
- Optimised heat integration



The technology by Cortus Energy

- Use for producing synthesis gas (CO/H₂)
- Pyrolysis converts biomass into pyrolysis gas and char
- Pyrolysis gas is combusted to generate heat for the gasification
- Gasification of char with steam



WoodRoll® – Versatile green Energy gas

WoodRoll® is a unique technology that replaces fossil energy by efficient gasification of biomass that produces green energy for vehicles, industry and power generation.

Feedstock

Forest-based feedstock such as forest residues and energy crops.

Waste from industry such as fiber sludge and construction waste.

Agricultural waste such as animal manure and crop residues.

1 The biomass is heated and dried (100° C).

2 During the pyrolysis the biomass is converted into pyrolysis gas and char (400 °C).

3 The pyrolysis gas is burned and heats gasification, waste heat goes to pyrolysis and drying.

4 In the gasifier finely ground char reacts with steam (1,100 °C) and form a clean energy gas.

5 The energy gas is cooled with water that becomes steam, which is feed to the gasifier.

Applications

Biogas

Renewable power

Hydrogen

Industry

35 tons of biomass (equivalent to a lorry with trailer) one-day operation of a WoodRoll® = 100 oil barrels

Project contents

Research on high temperature corrosion in plants for gasification of biomass and waste

- Material degradation by oxidation, corrosion and/or carburisation in environments with low oxygen activity
 - Studies of influence of the gas environment and/or of corrosive deposits
 - Studies of the relation of the degradation attack to alloy type (Fe-base or Ni-base), alloying elements, microstructure and/or oxide type (chromia or alumina)

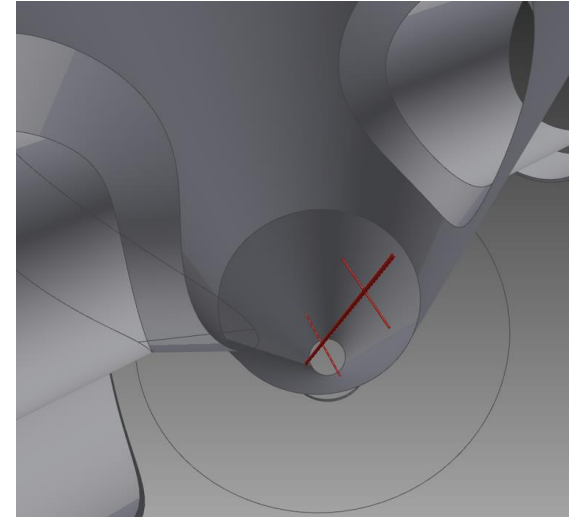
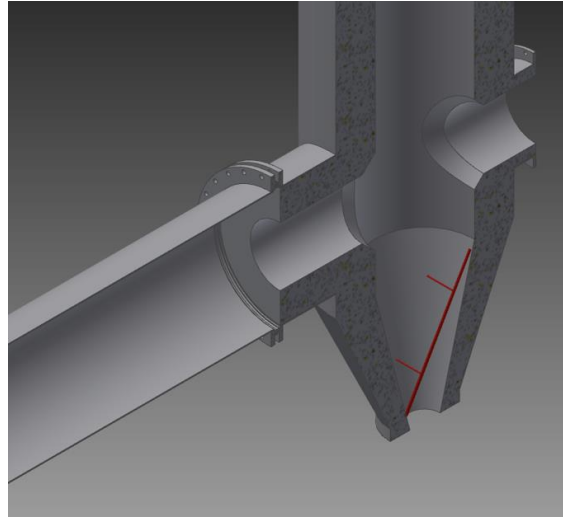
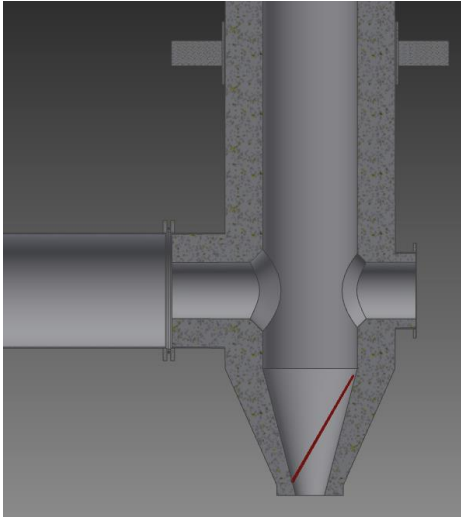
Project contents

A number of important research topics of particular interest have been identified. These include the following that may be addressed in the project:

- Influence of very high water content in the gas (~ 50-60 vol.%)
- Influence of very high temperatures (~ 800-1100 °C)
- Influence of KCl at intermediate temperatures (~ 400-500 °C)

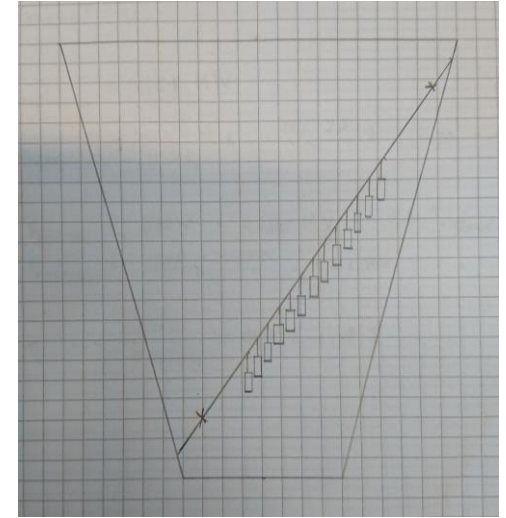
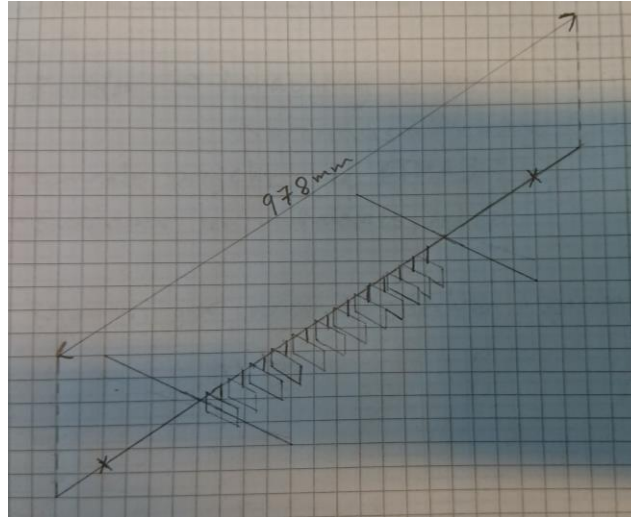
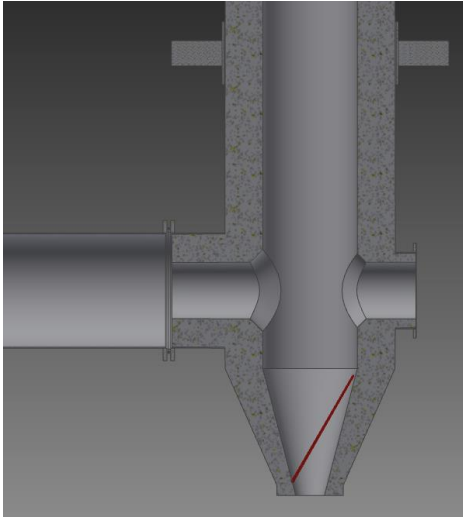
Project plan 2019-2020

- Field testing by RISE KIMAB



Project plan 2019-2020

- Field testing by RISE KIMAB



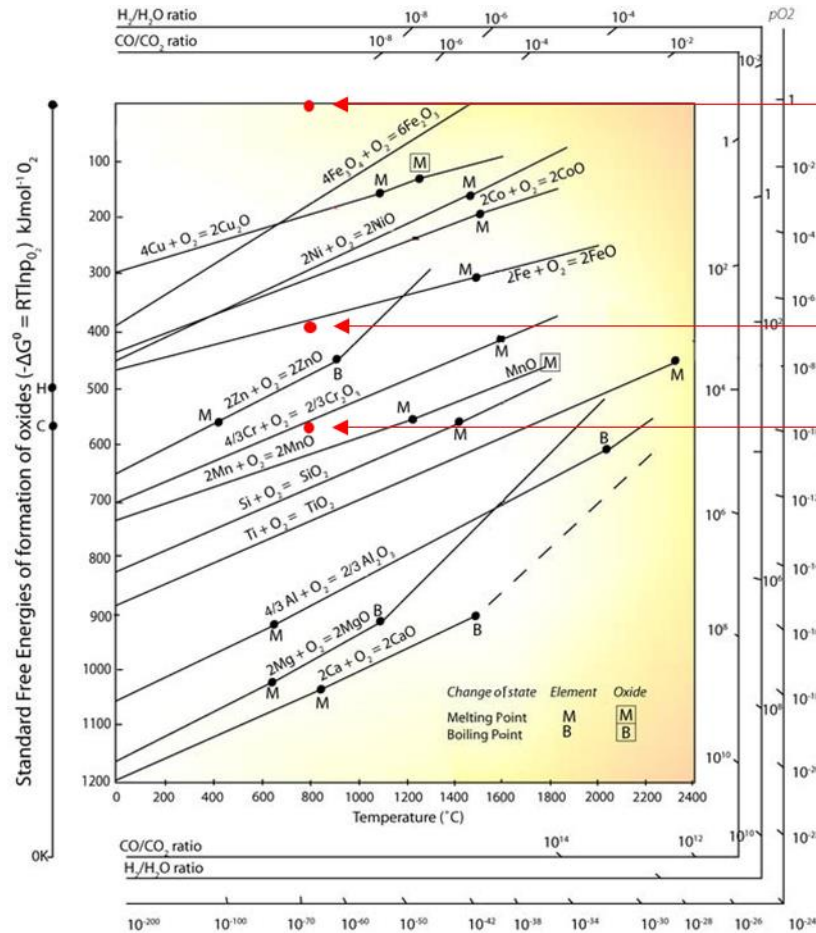
- 30 mm sample height (+ 50 mm hanging wire)
- 15 mm distance between samples

Alloys tested

Grade	7RE10 (310H)	SANICRO 70 (Alloy 600)	A197	A198	APMT
ELEM	wt.%	wt.%	wt.%	wt.%	wt.%
NI	20.16	Bal.			
CR	24.31	16.73	12.4	10.1	21
SI	0.34	0.31	1.25	0.3	
MN	1.24	0.19	0.1	0.2	
AL		0.14	3.7	4.0	5
TI		0.33			
FE	Bal.	9.76	Bal.	Bal.	
Other			RE	RE	RE

Exposure environments

Environment	Gas comp.	Temp.	Measured Dew point	Measured water content	Calculated a_{O_2}
Air	Air	800 °C	-59.3 °C	11.9 ppm	~0.21
Nitridation	95% N ₂ , 5% H ₂ , 3.3 ppm O ₂	800 °C	-63.7 °C	6.5 ppm	$7.7 \cdot 10^{-27}$
Gasification	20% H ₂ , 20% H ₂ O, 60% Ar	800 °C	60.4 °C	20%	$4.4 \cdot 10^{-19}$

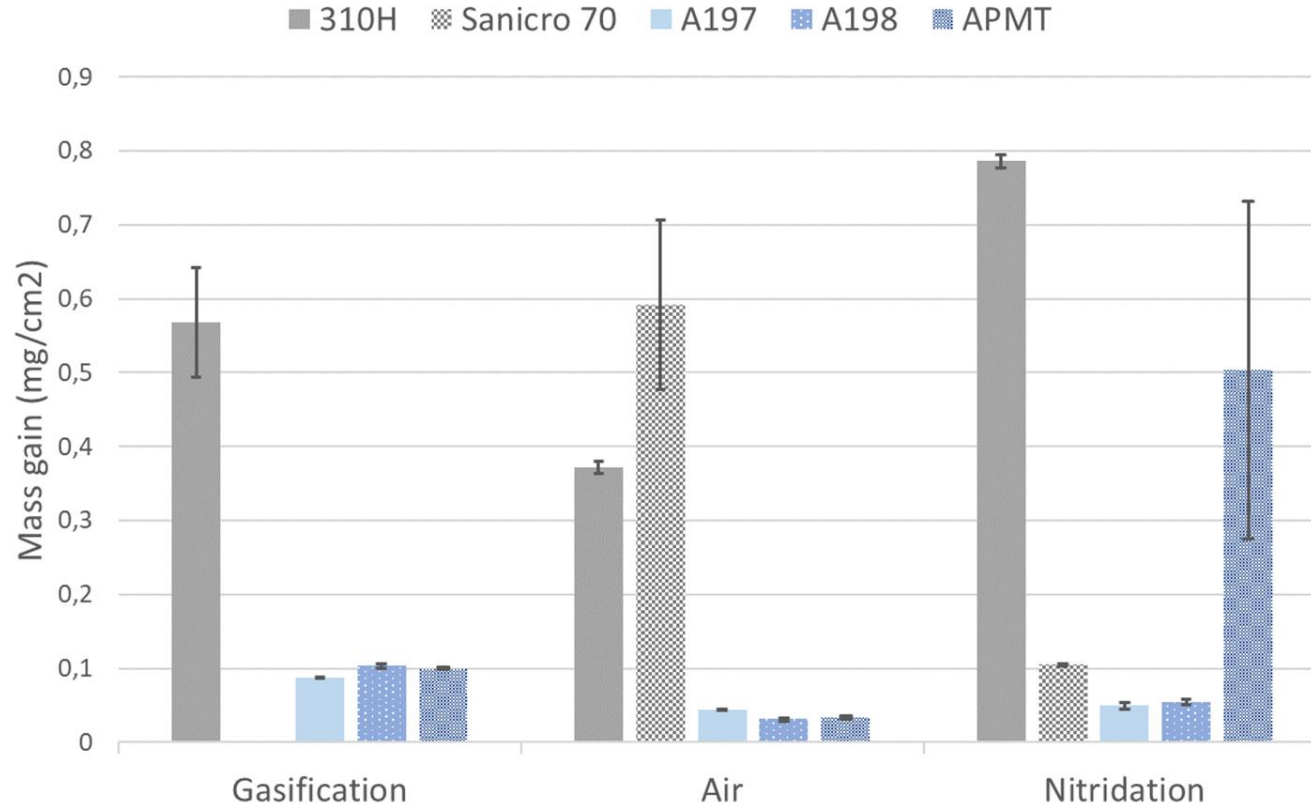


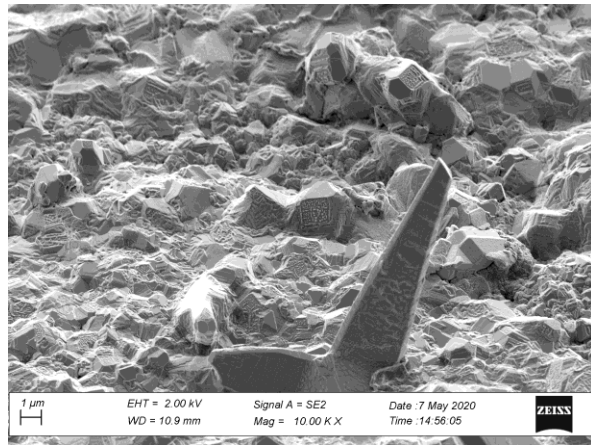
Air

Gasification

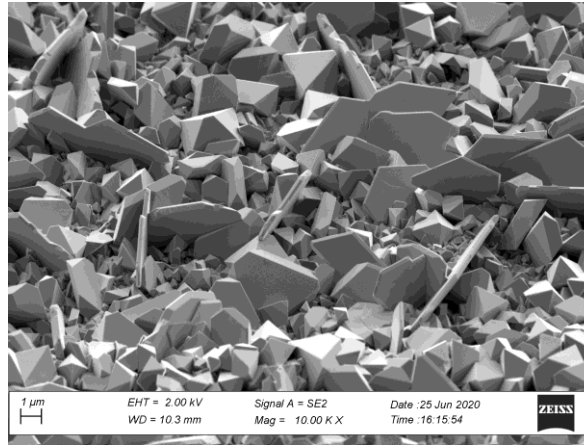
Nitridation

Mass gains after 168 h (1 week) at 800 °C

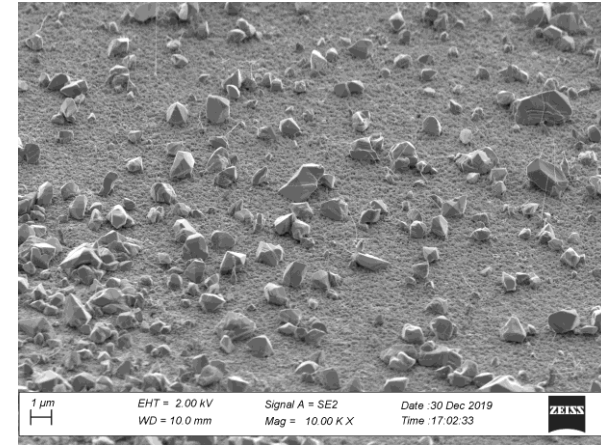




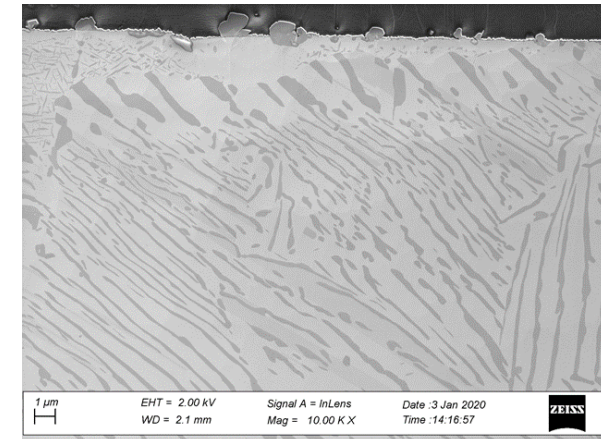
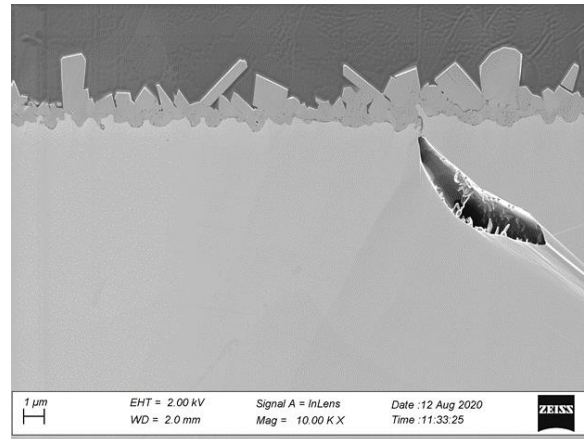
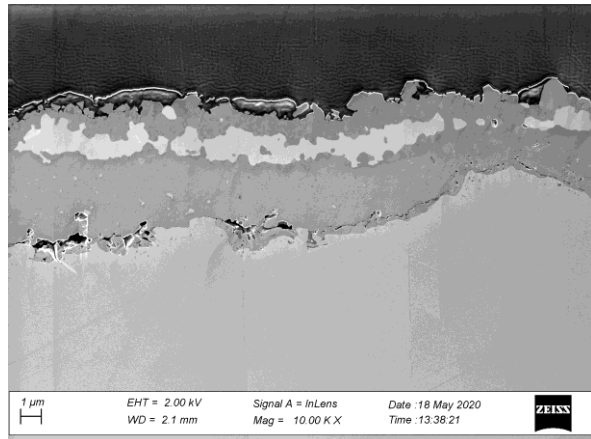
Gasification

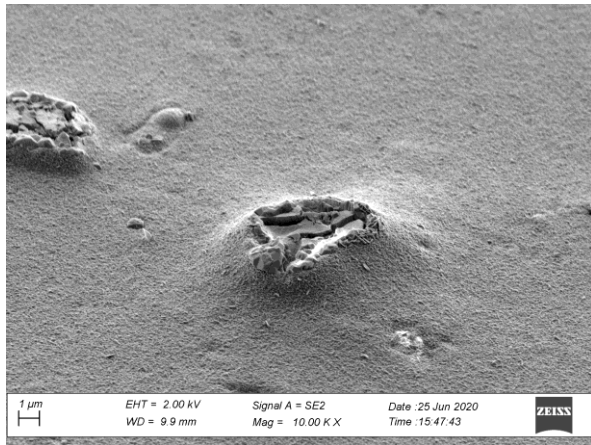


Air

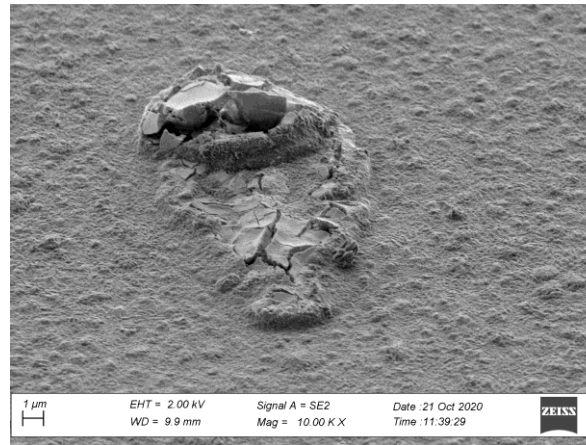


Nitridation

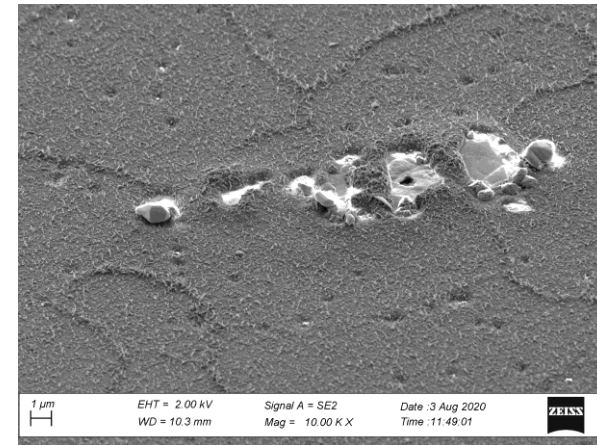




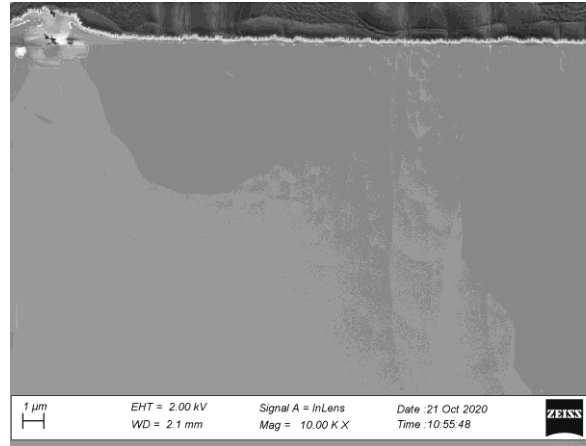
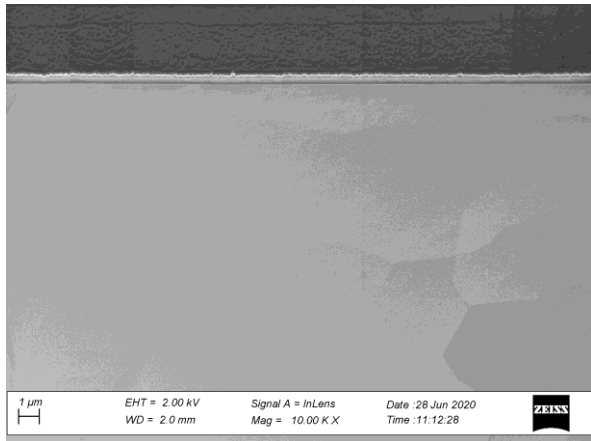
Gasification



Air



Nitridation



Next steps

- More detailed microscopy
- Exposures at higher temperatures (1000 °C) and higher water content (50 %)

A large, light red dotted grid pattern covers the left half of the slide, extending from the top to the bottom and from the left edge to the center.

Thank you for listening!