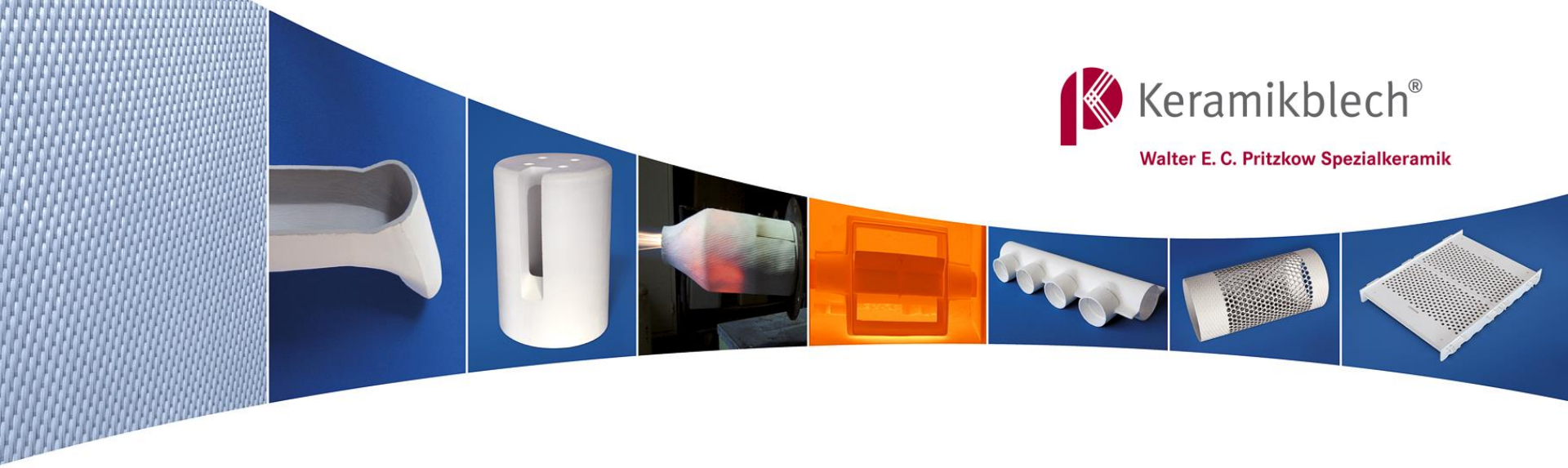

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Thin walled and light weight all oxide ceramic matrix composites (OCMC) structures as substitute for sheet metals

Walter Pritzkow

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Introduction

- Material basics
- Production process
- Why using OCMC instead of metal
- Structures under extreme thermo-shock
- Tubular systems with better strength and better insulating properties
- Light weight structures for unmanned aerial vehicles
- Summary

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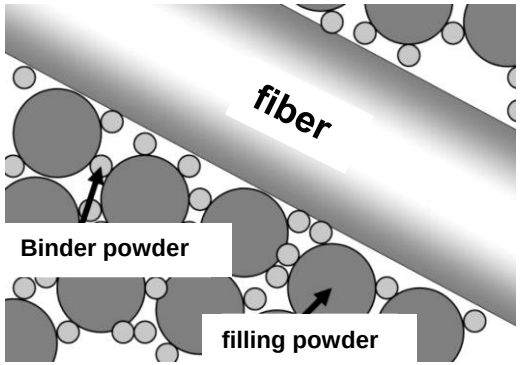
Material basics from textil based OCMC‘s produced by WPS

Fabrics and braided sleevings made of

- 3M™ Nextel™ 610, 3M™ Nextel™ 720
- Nitivy
- Silica

Waterbased slurry made of

- Binder powder: system Al_2O_3 - SiO_2 - ZrO_2
- Filling powder: system Al_2O_3 - SiO_2



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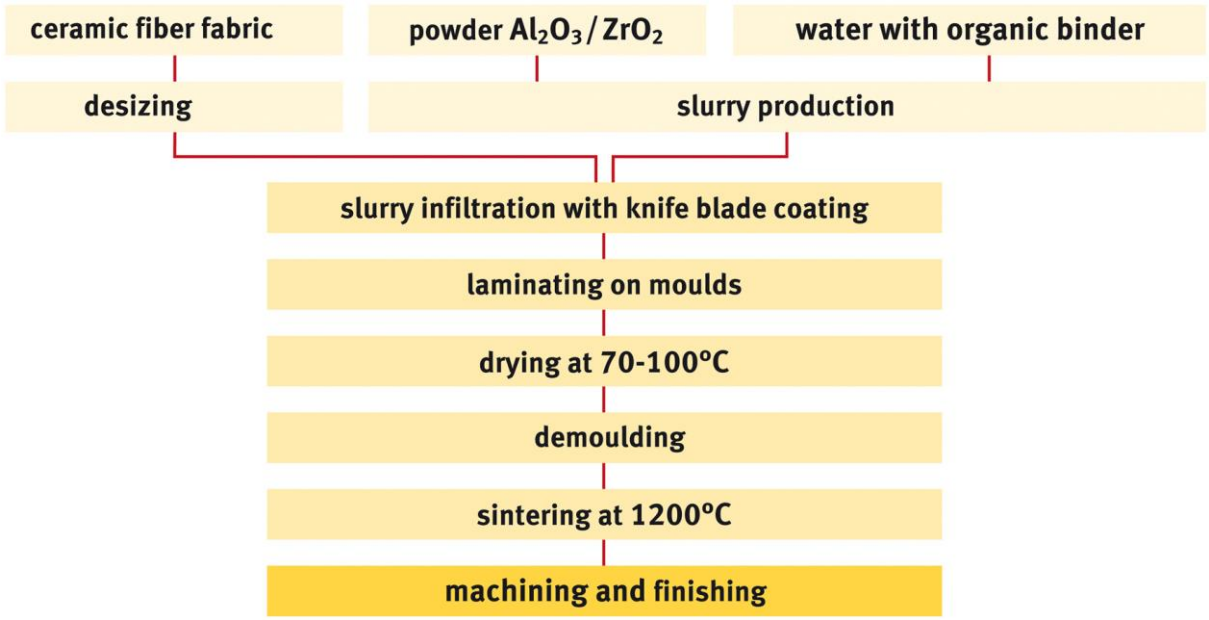
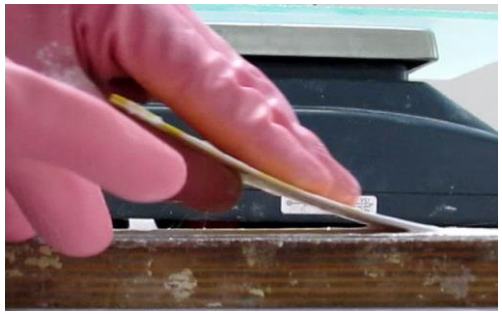
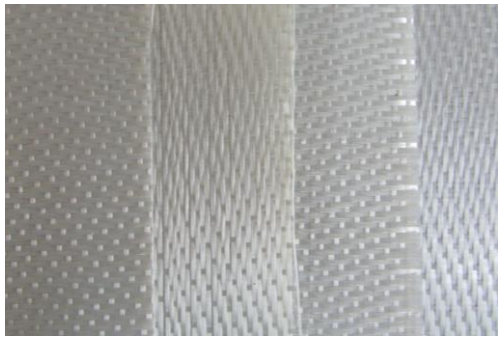
Processing of OCMC‘s at WPS





Slurry infiltration by hand
with knife blade coating



Standard Layup with
3M™ Nextel™ 610 fabric type DF11

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Why using OCMC instead of metal?

Fracture due to thermal gradient and high thermal expansion

Deformation due to thermal gradient and high thermal expansion

High temperature corrosion / scaling

Life time is more than factor 10 of metal parts

Lower thermal expansion (50% of steel) reduces stresses in the structure

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Material characteristics from sliding carriage loaded with metal test pieces after extreme thermo-shock cycles

Dimensions:

Length: 345mm

Width: 274mm

Thermo-shock cycles:

RT to 1000-1140 ºC

Heating by moving the sliding carriage into the hot furnace.

Dwell time: 1 hour

Cooling like heating

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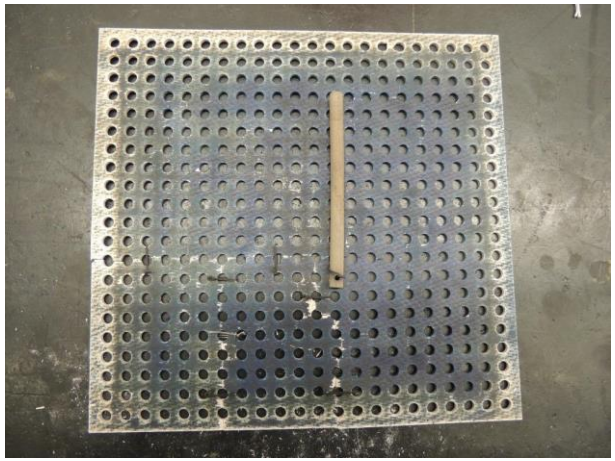
Sliding carriage after 8000 cycles extrem thermo-shock



Deformations are seen, but these are no problem for the operation of this sliding carriage

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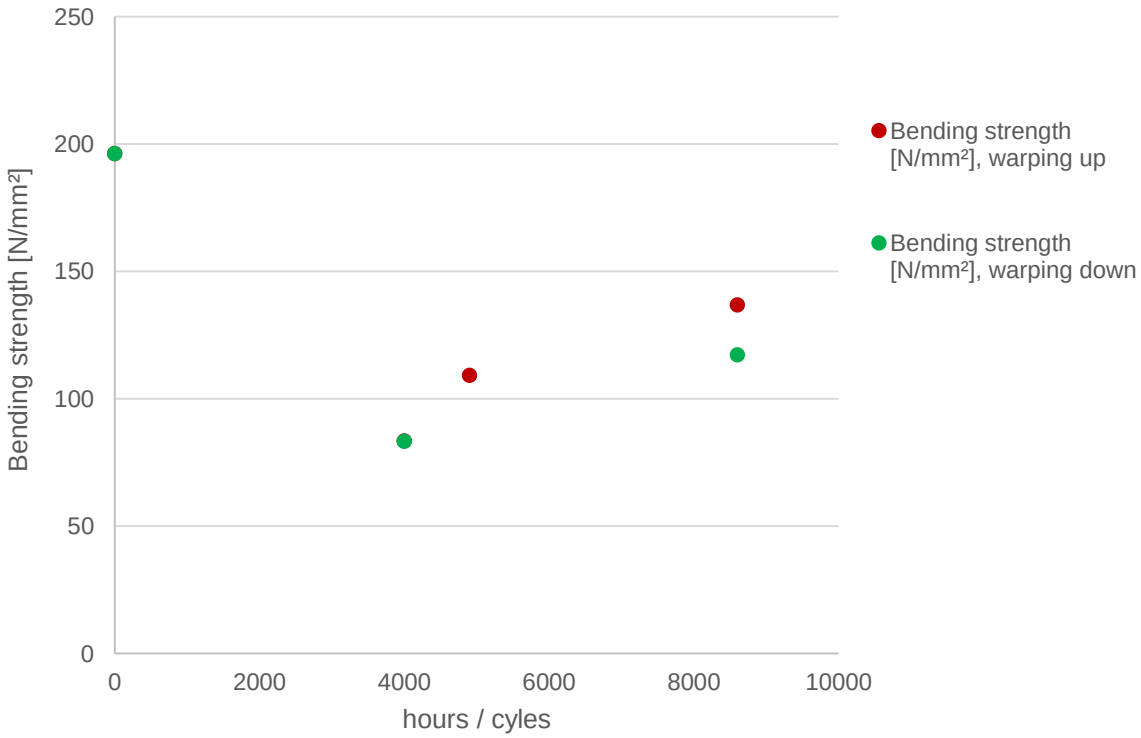
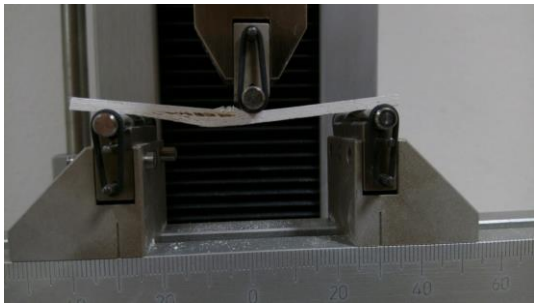
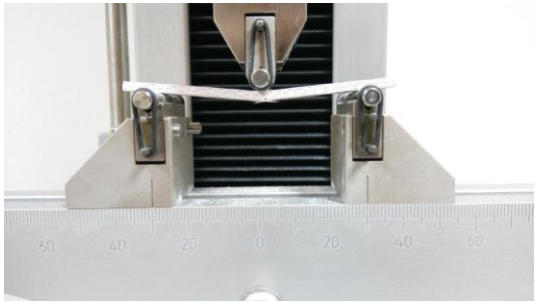
Bending strength after extrem thermo-shock



Bending test of as produced samples 0 hours / cycles



Bending test after 8600 hours / cycles



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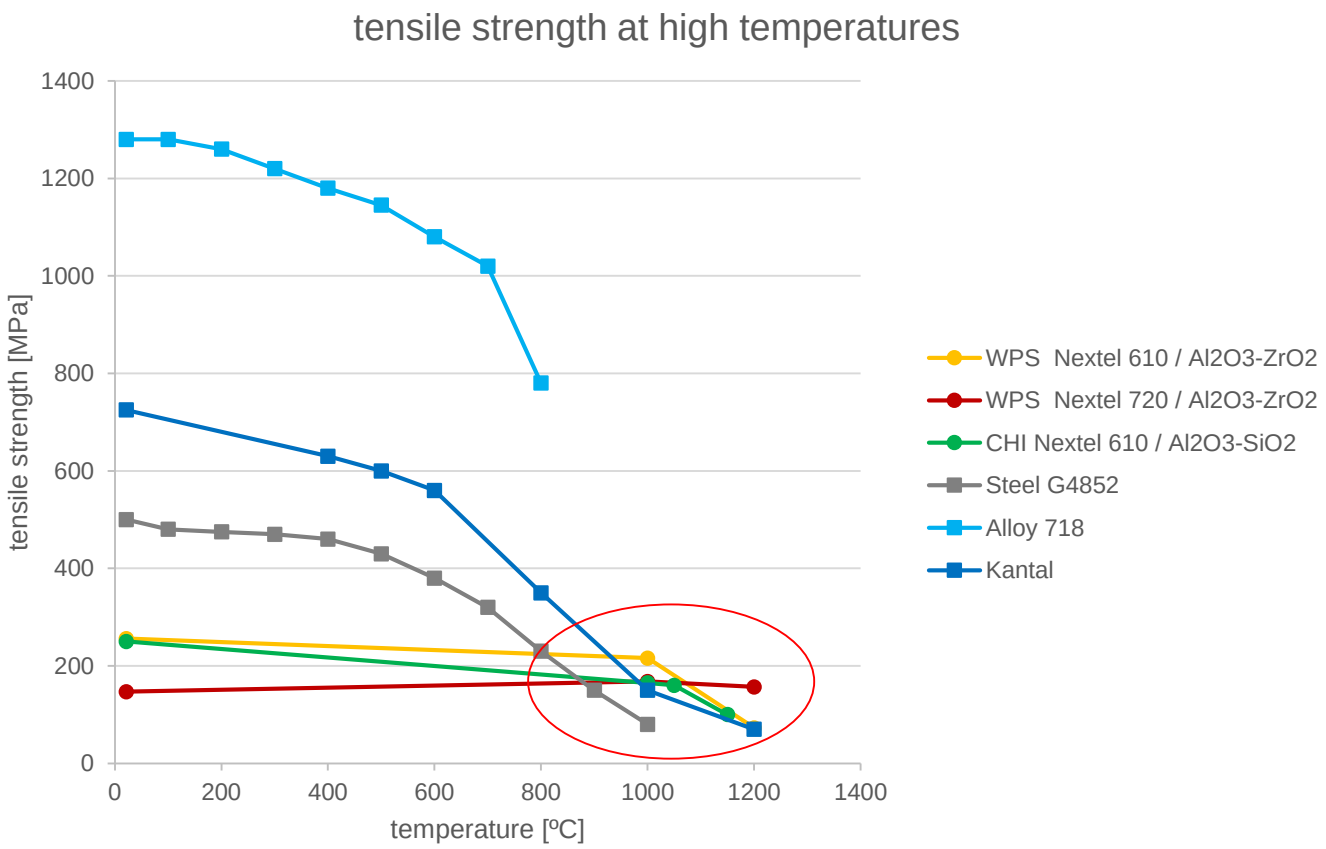
Tensile strength of metal and OCMC at high temperatures



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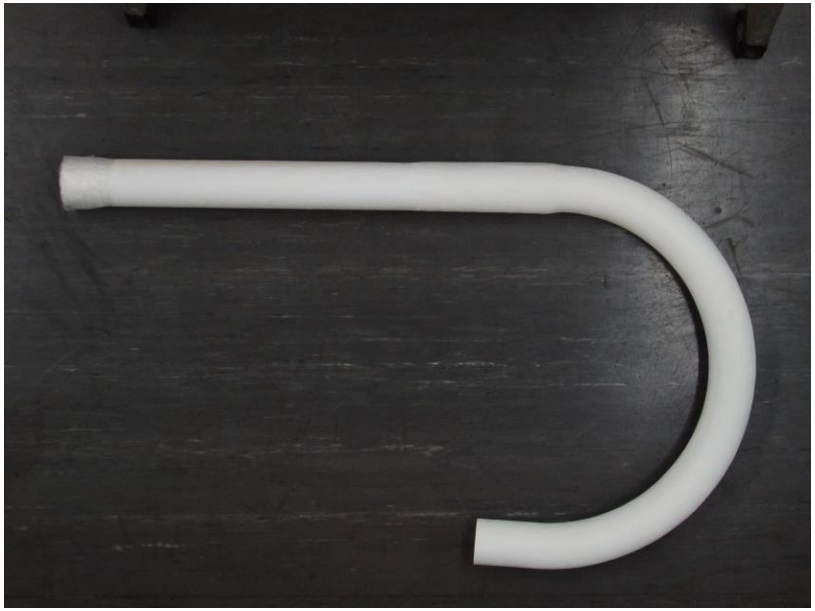
Tubular systems for chemical plant construction



- Fabric based OCMC for straigth tubes
- Braided sleeving based OCMC for curved tubes

→ Tubular systems in one piece are possible

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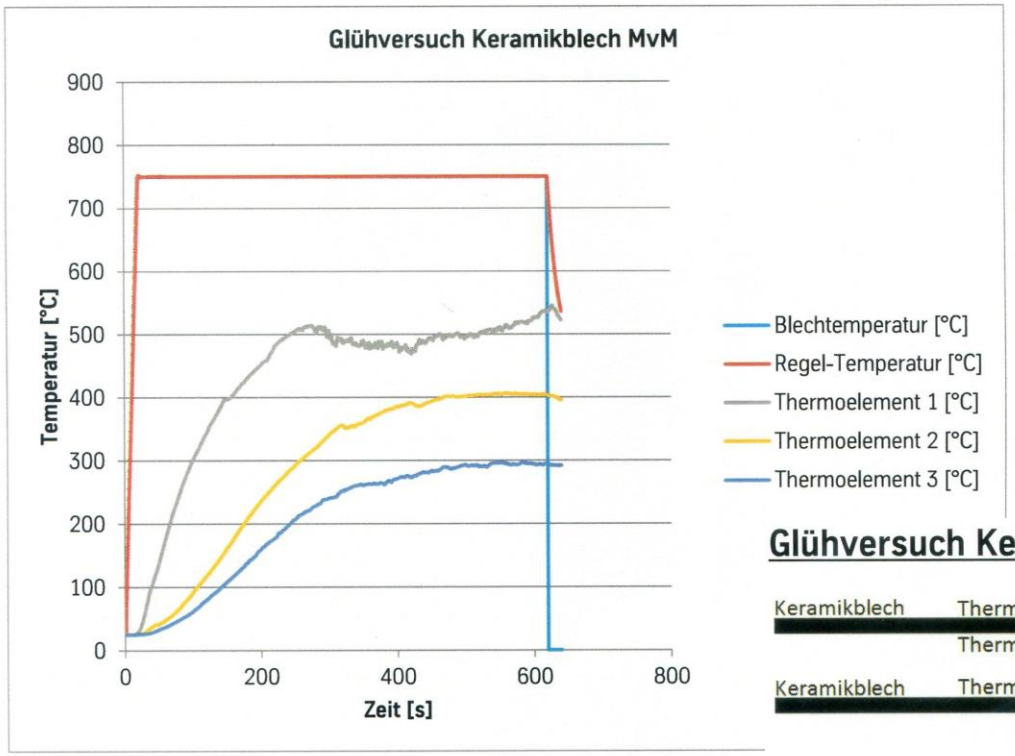
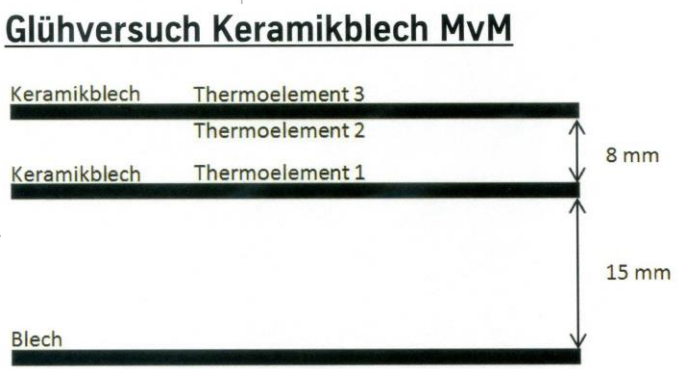
Good insulating material with a low thermal conductivity and a low emissivity



Temperature [ºC]	Thermal conductivity [W/mK]
300	3,8
600	2,81
900	2,3
1100	2,02



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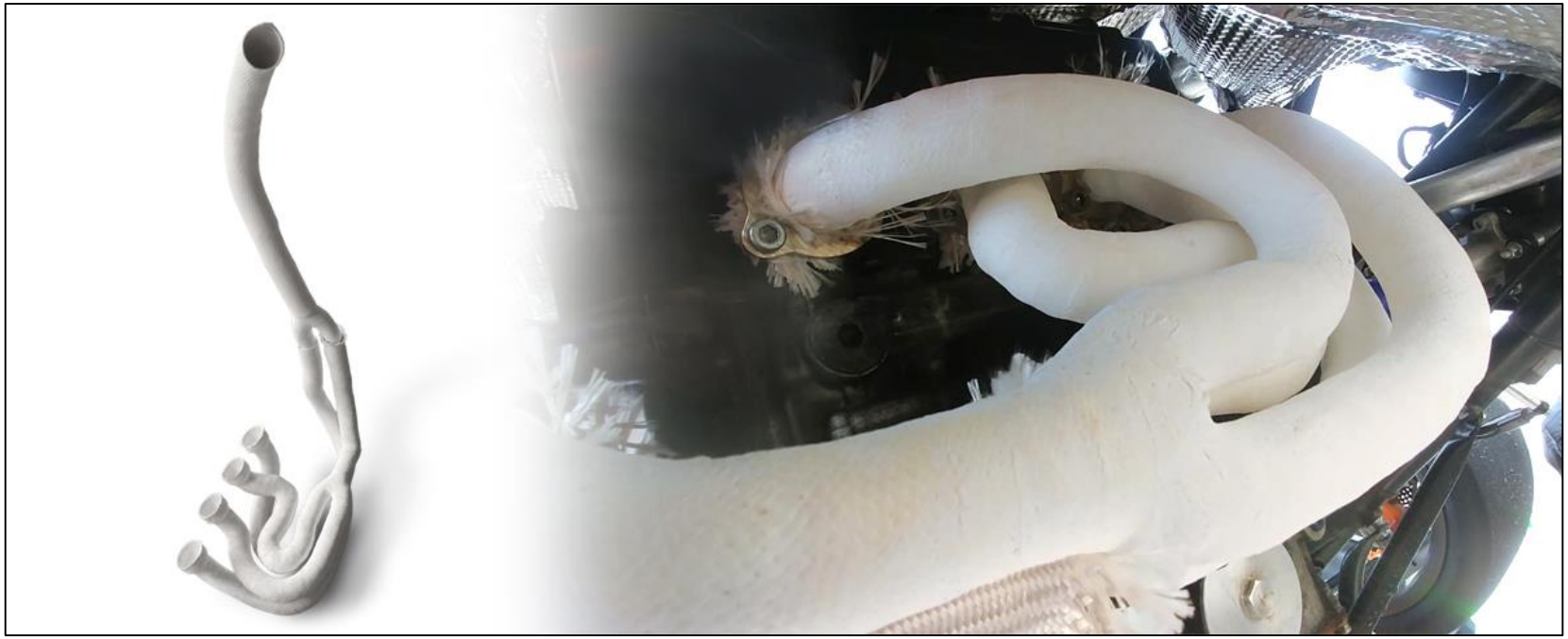
Extremly complex exhaust manifold for a racing car for the Formula Student „Bodensee Racing Team“ Constance



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Light weight structures for unmanned aerial vehicles (1)

- Low density 2,8 g/cm³ compared to metal with a density of 7,8 g/cm³
- Thin-walled structure with a wall thickness of about 1,5mm
- Large self supporting structures are possible

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Light weight structures for unmanned aerial vehicles (2)

- Large self supporting and moving structures are possible
- The weight of the small metal swivels is in the same range than the thrusters and the tube.

Summary

- Due to lower thermal expansion than steel, cracks and deformation can be avoided
- Due to thin wall thickness and low thermal expansion a good thermo-shock resitance is reachable.
- OCMC has higher tensile strength than standard high temperture steel.
- For some applications the good low thermal conductivity his helpful
- Due to the possibility to produce thin wall thicknesses and due to the low density of OCMC, ultra-lightweight structures for flying vehicles are possible

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Thanks for your attention

Solar absorber D=2,5m H=2,5m