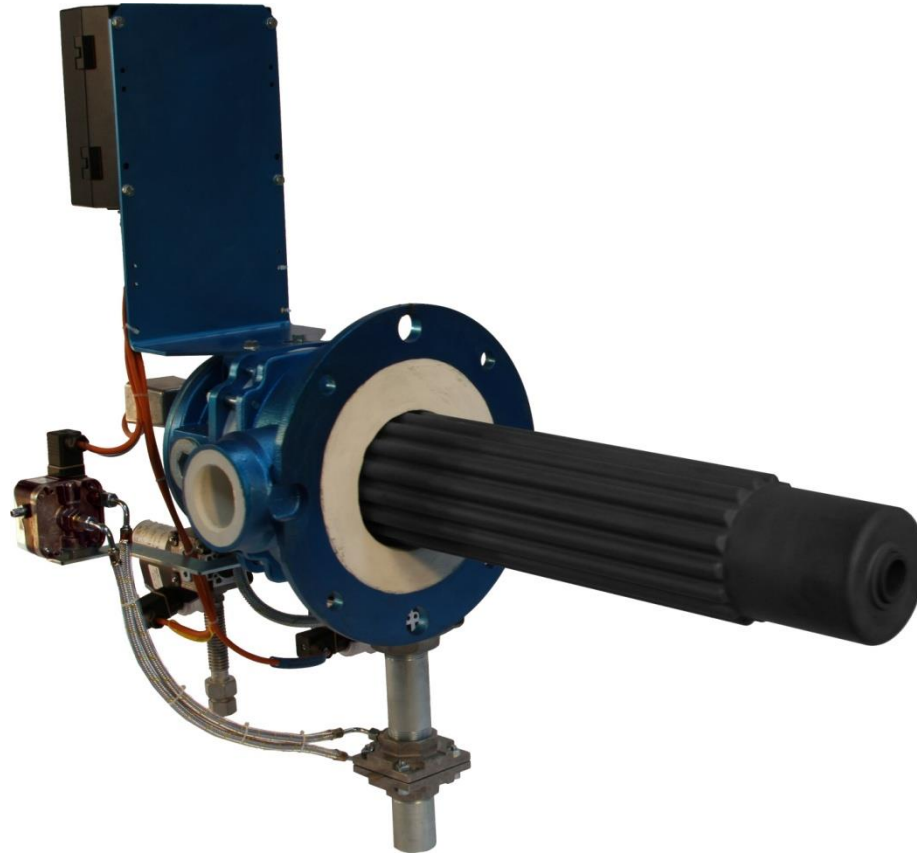


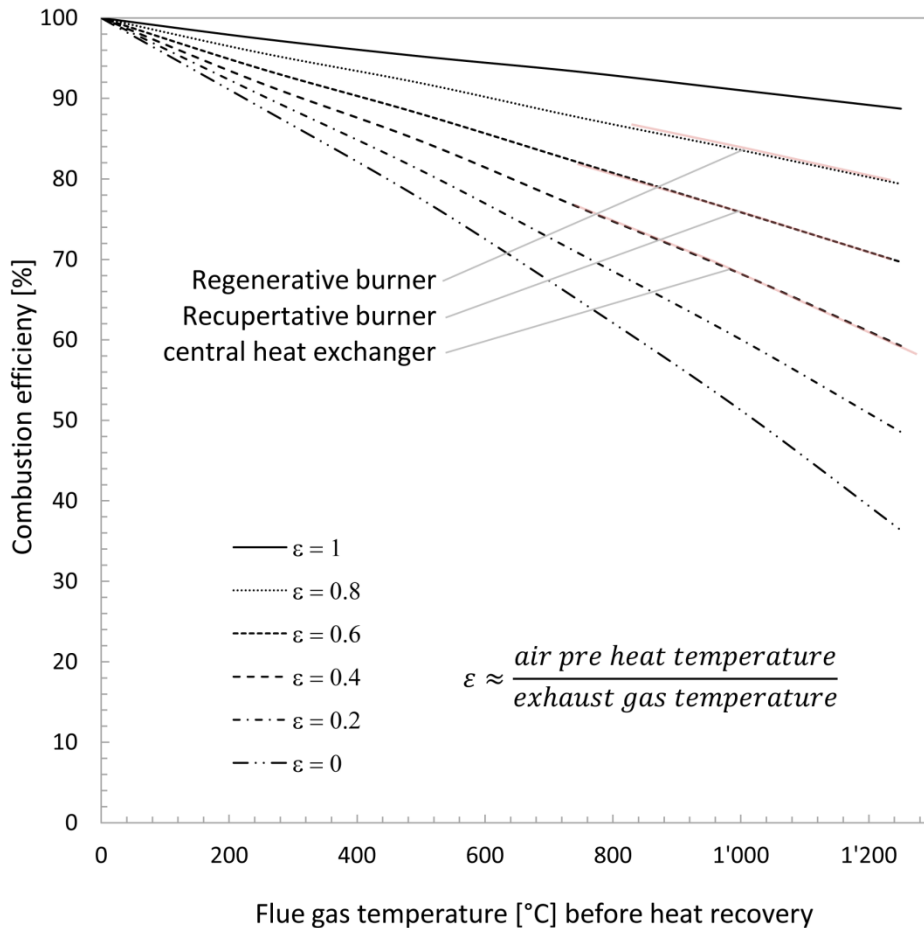
Si-SiC heat exchangers with highly structured surface elements for recuperative gas burners

A. Ortona*, SUPSI, Switzerland; S. Gianella, Erbicol, Switzerland; D. Trimis, V. Uhlig, R. Eder, TU Bergakademie Freiberg, Germany; E. Boulet, C. Chazelas, Institut Français du textile et de l'habillement, France; T. Grämer, NOXMAT, Germany; G. D'Amico, P. Fino, Politecnico di Torino, Italy; E. Cresci, J. G. Wüning, WS Wärmeprozestechnik, Germany; H. Altena, Aichelin, Austria; F. Beneke, M. Debier, European Committee of Industrial Furnace and Heating Equipment Associations CECOF, Belgium

- Motivation
- CFD analysis
- Textile
- Ceramisation
- Testing
- Results

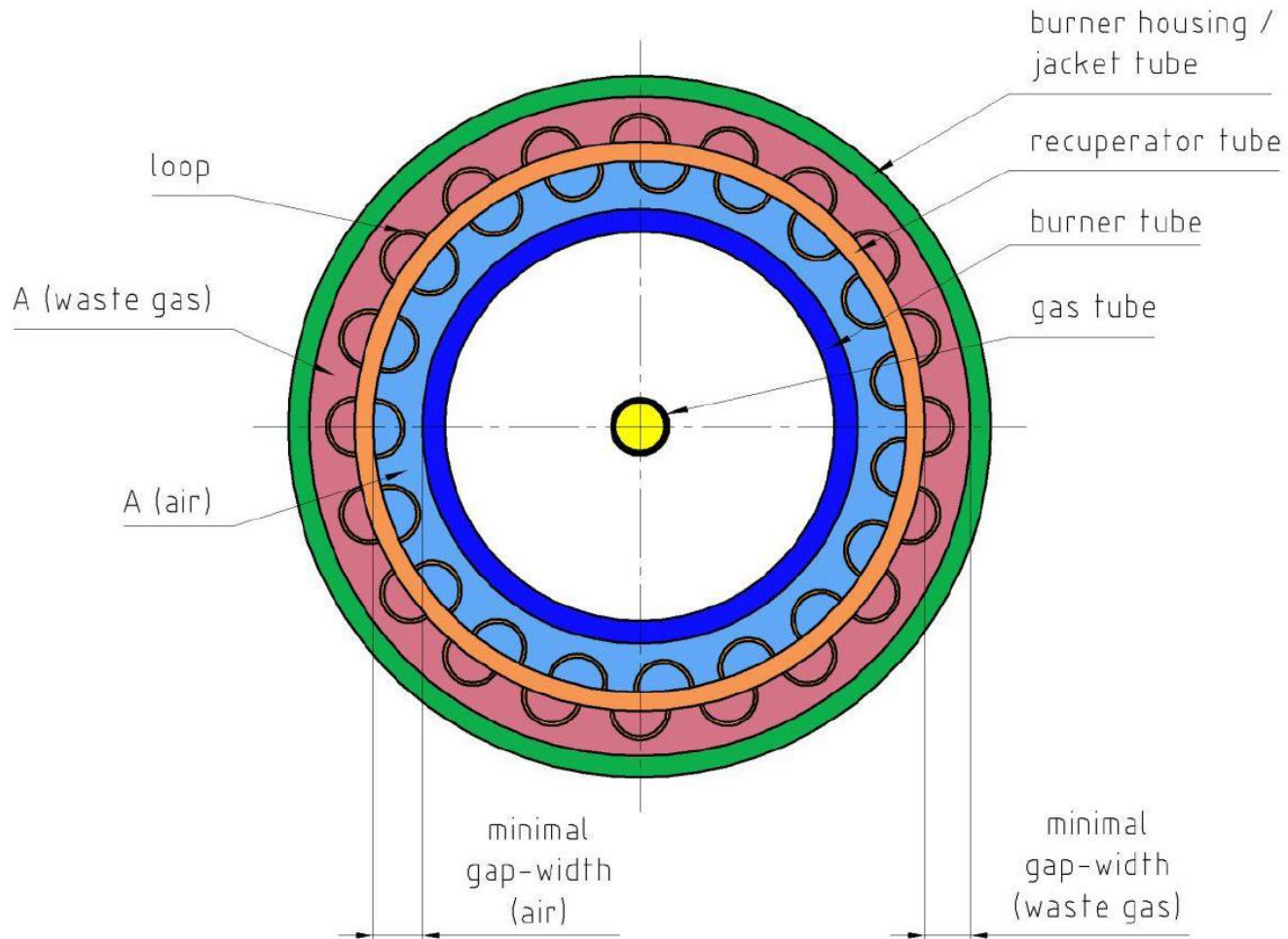


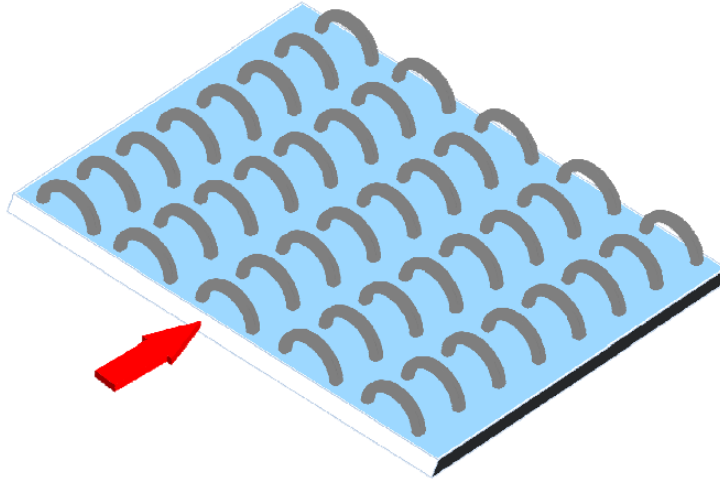
Typical burners of NOXMAT GmbH with ceramic heat exchanging parts



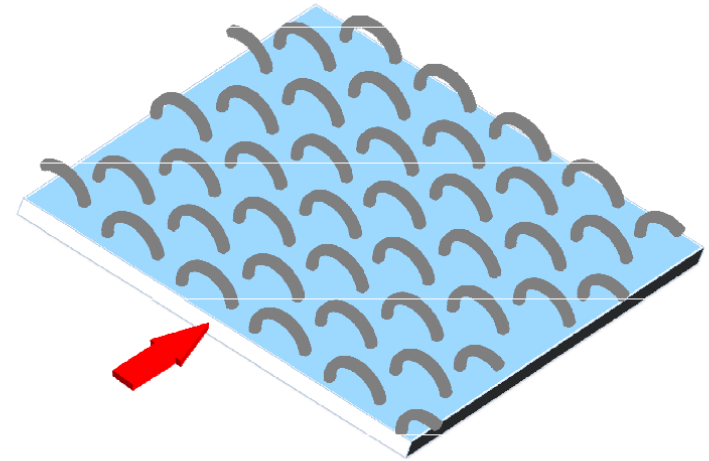
Industrial branches of high energy consumption are the metal industry (steel and alloys), glass industry and ceramics production and processing. Since most of the relevant **processes are operated at a high temperature**, heat recovery becomes essential in terms of efficiency. The most common way to recover heat is by preheating the air or other gasses with hot effluent gasses. The so called **recuperative or regenerative heat exchanger systems**, which may be integrated in the burner assemblies, are commonly used for this purpose.

The concept



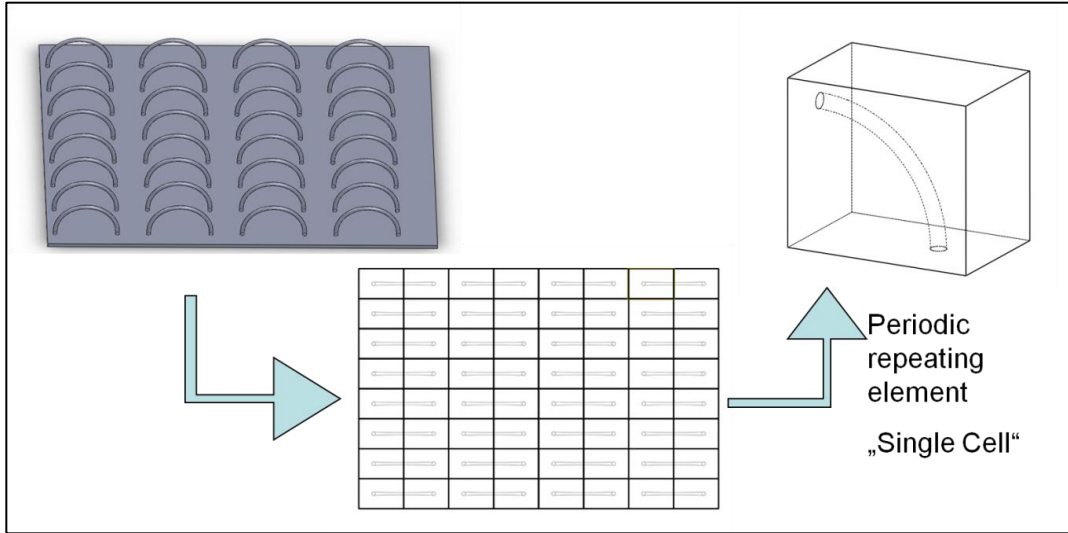


Geometry 1

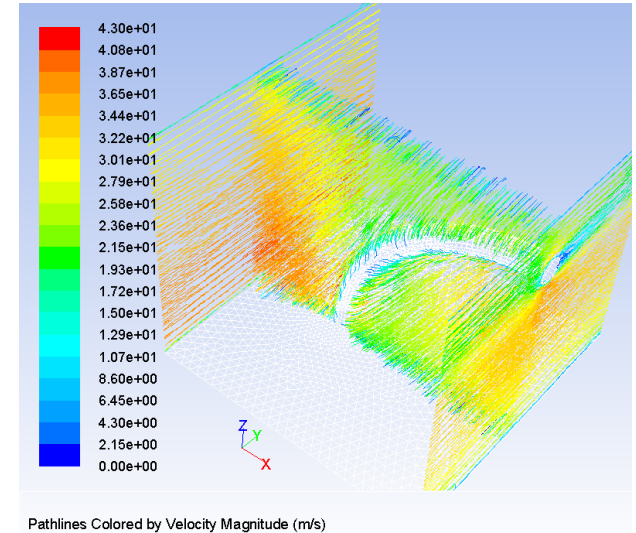


Geometry 2

Trimis, D., V. Uhlig, et al. (2011). "NEW CERAMIC HEAT EXCHANGERS WITH ENHANCED HEAT TRANSFER PROPERTIES FOR RECUPERATIVE GAS BURNERS." Heat Processing **9(2): 183-187.**

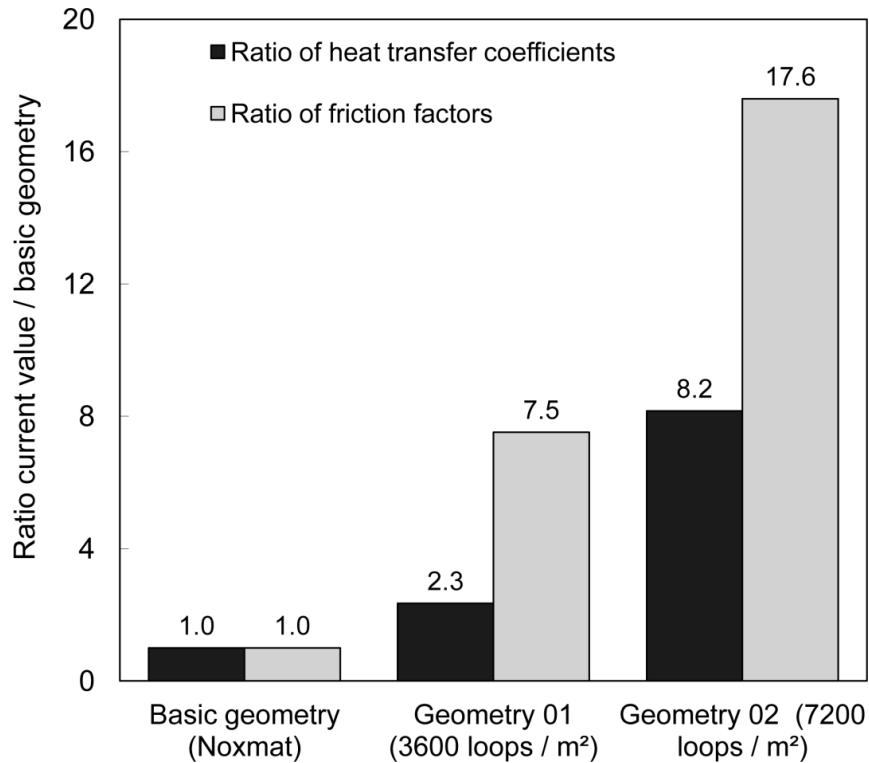


Path from ceramic structure to one repeating single cell



Result of a simulation with 3600 loops/m², here velocity field

Trimis, D., V. Uhlig, et al. (2011). "NEW CERAMIC HEAT EXCHANGERS WITH ENHANCED HEAT TRANSFER PROPERTIES FOR RECUPERATIVE GAS BURNERS." Heat Processing **9(2): 183-187.**

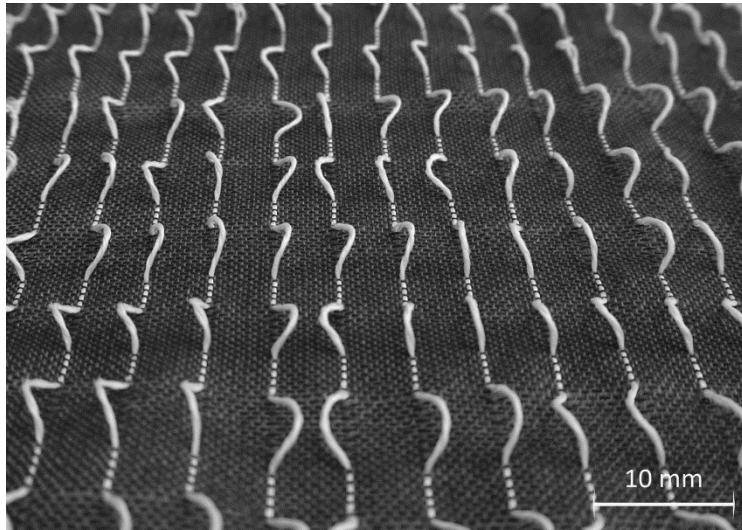


This example calculation indicates, that the targeted recuperator design will result in either significantly **higher heat recovery** levels at the same overall burner size as the current recuperative burners **and slightly higher pressure losses**, or alternatively to approximately the same heat recuperation level at significantly smaller size and lower pressure losses

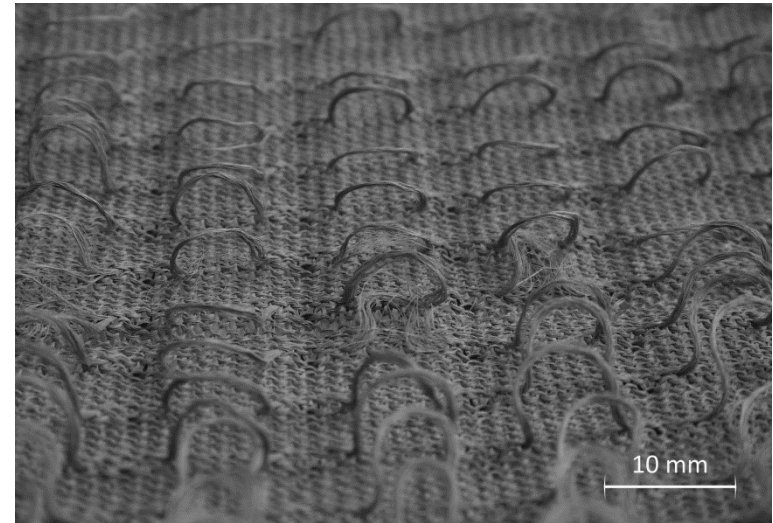
Trimis, D., V. Uhlig, et al. (2011). "NEW CERAMIC HEAT EXCHANGERS WITH ENHANCED HEAT TRANSFER PROPERTIES FOR RECUPERATIVE GAS BURNERS." Heat Processing **9(2): 183-187.**

Textiles design and fabrication

Fugitive and non-fugitive fibers were used; fugitive textiles (e.g. PE) degrade during firing leaving hollow loops. Non fugitive textiles (e.g. SiC fibers) do not degrade during heat treatment and remain inside the loop



weaving

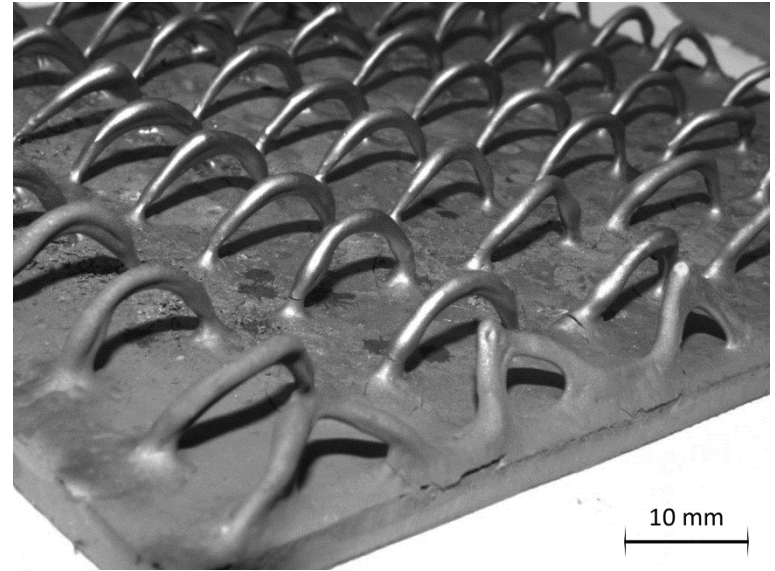


knitting

Ceramization



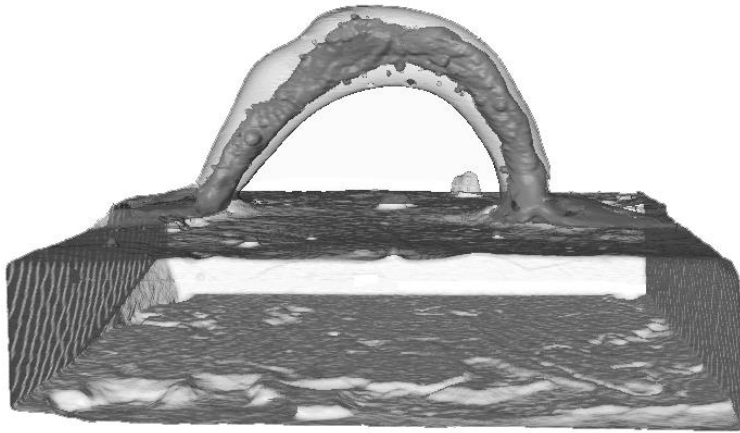
Slurry deposition



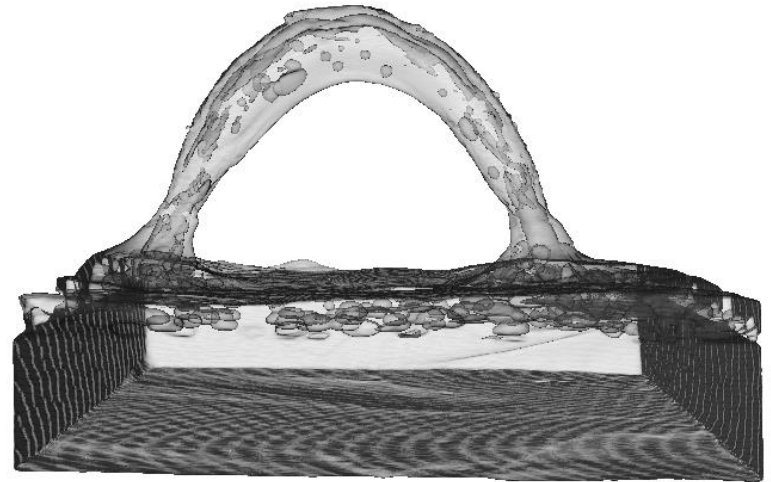
Pyrolysis

Silicon infiltration

Loop XTC analysis

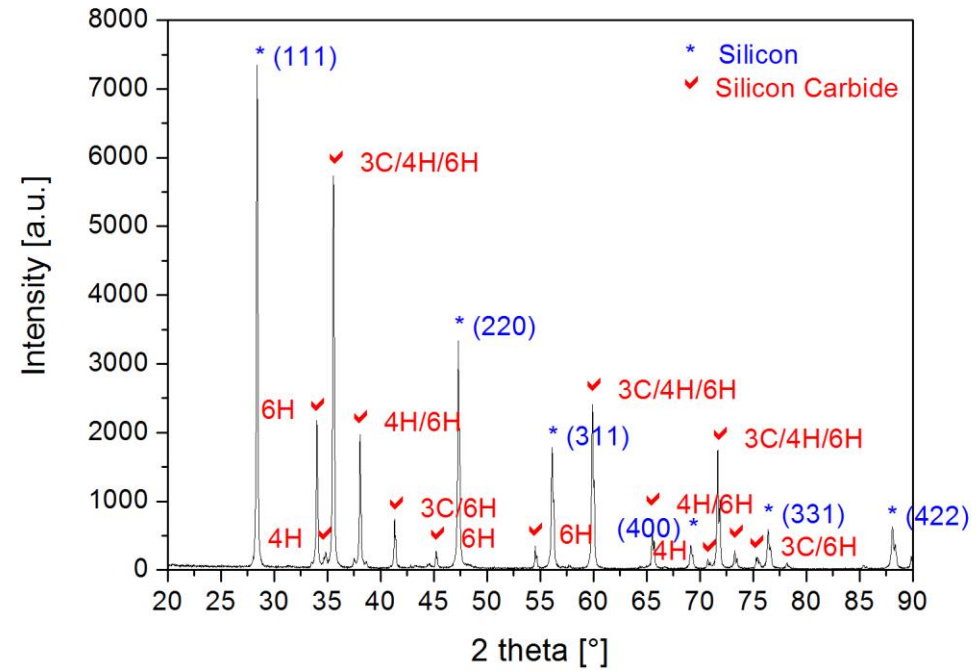
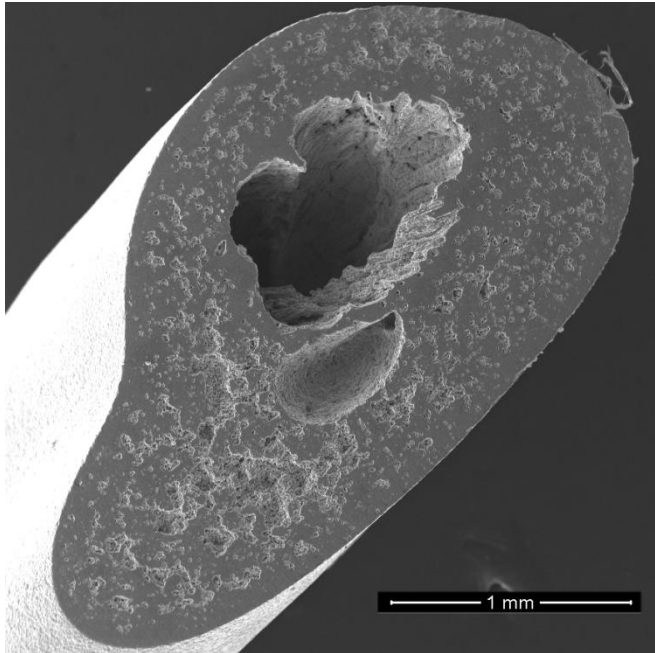


Fugitive fiber

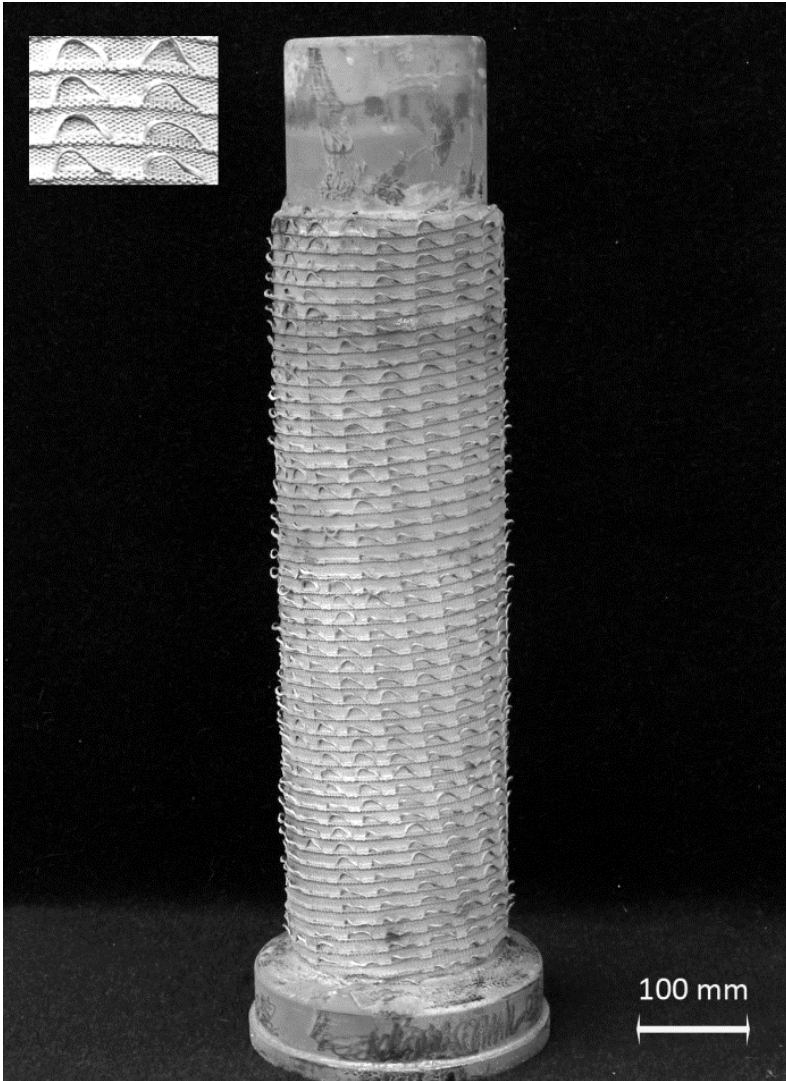


Non Fugitive fiber

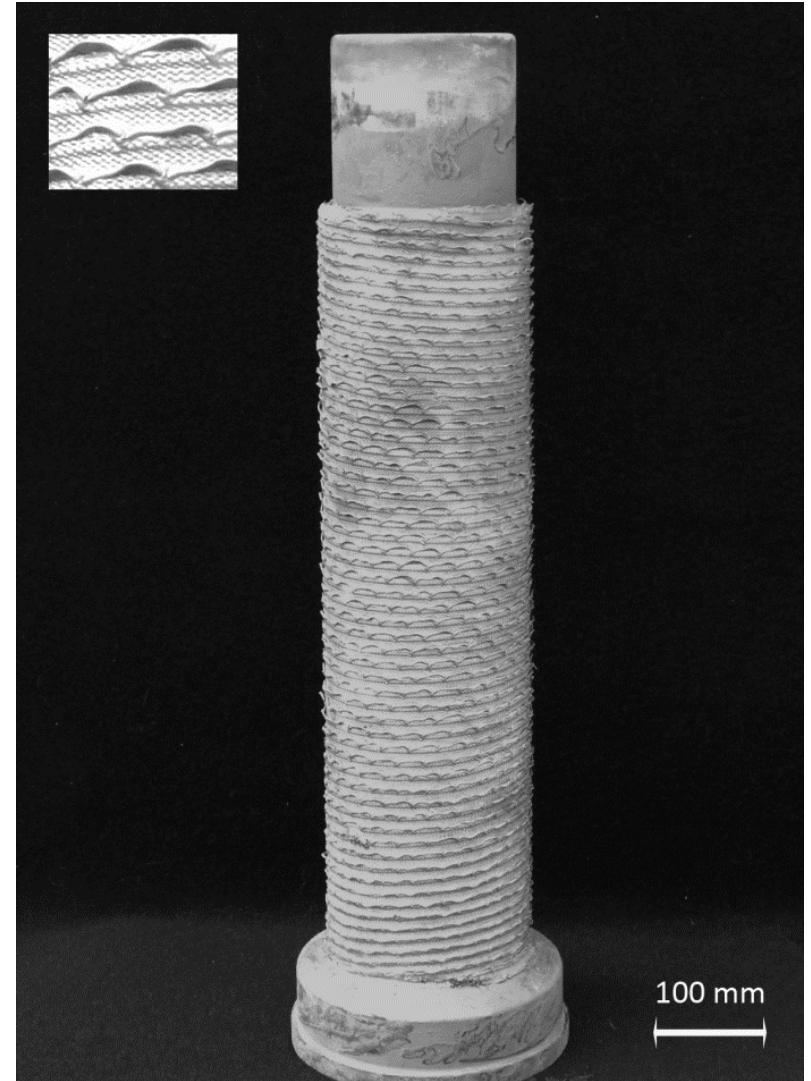
Loop material characterization



Prototypes fabrication

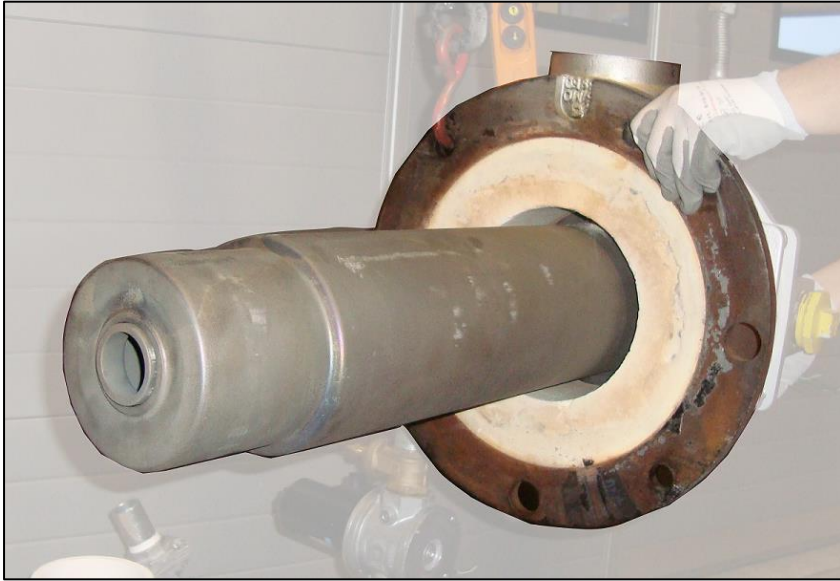


Geometry 1



Geometry 2

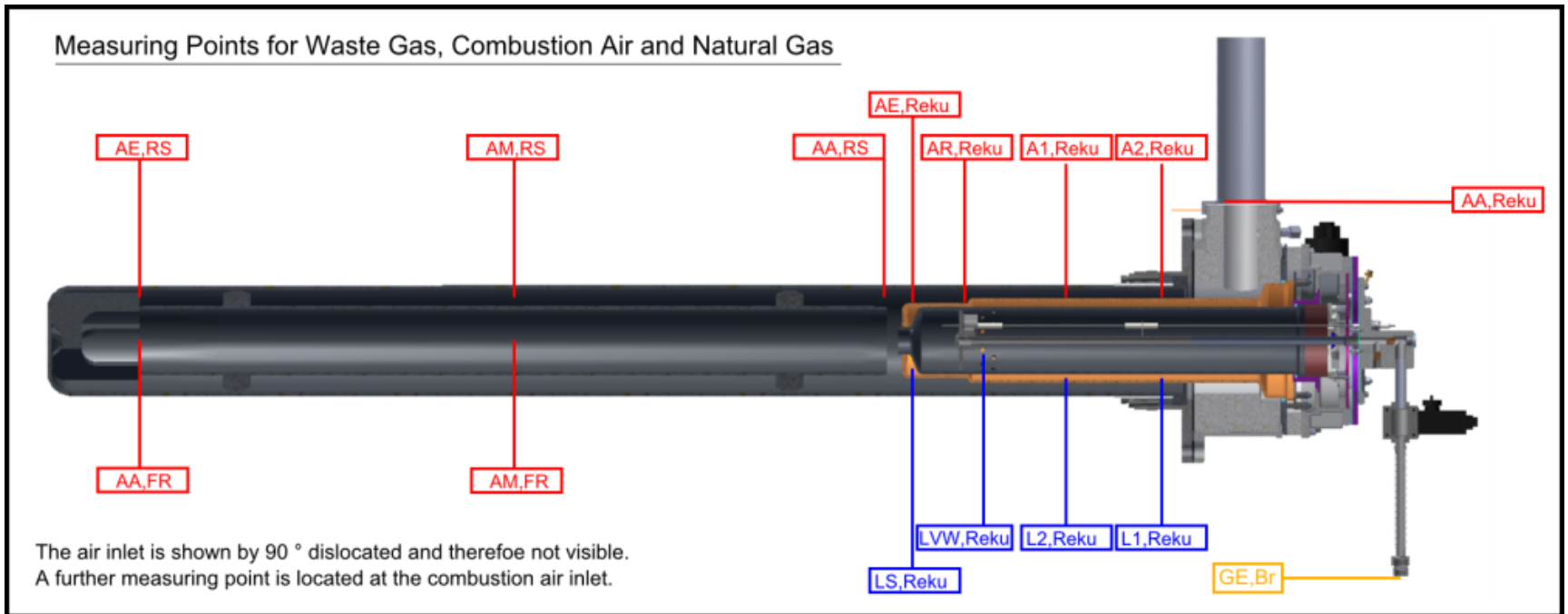
Burners assembly

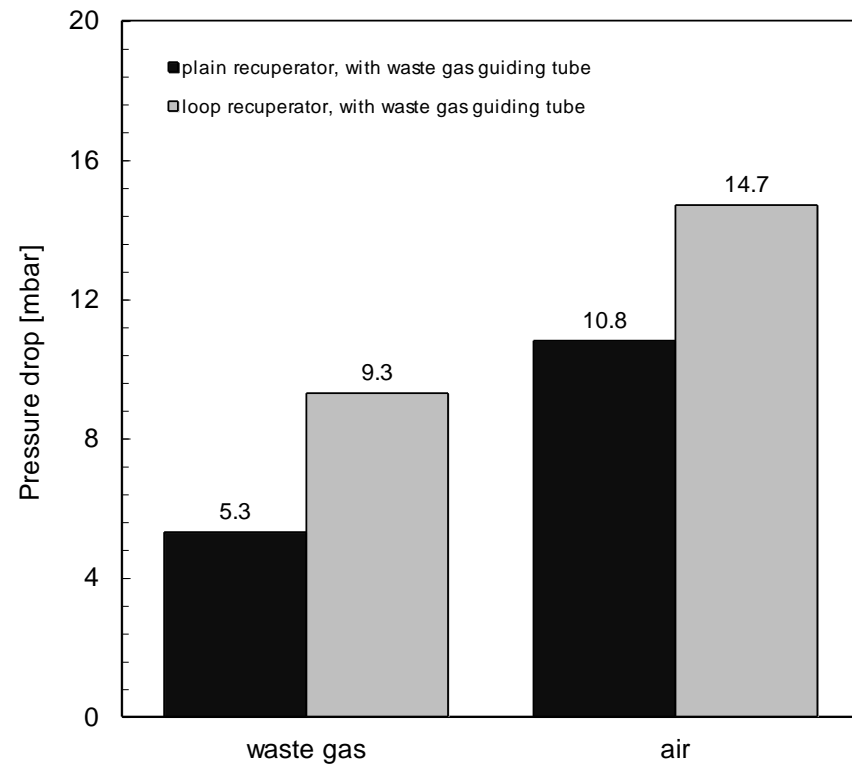
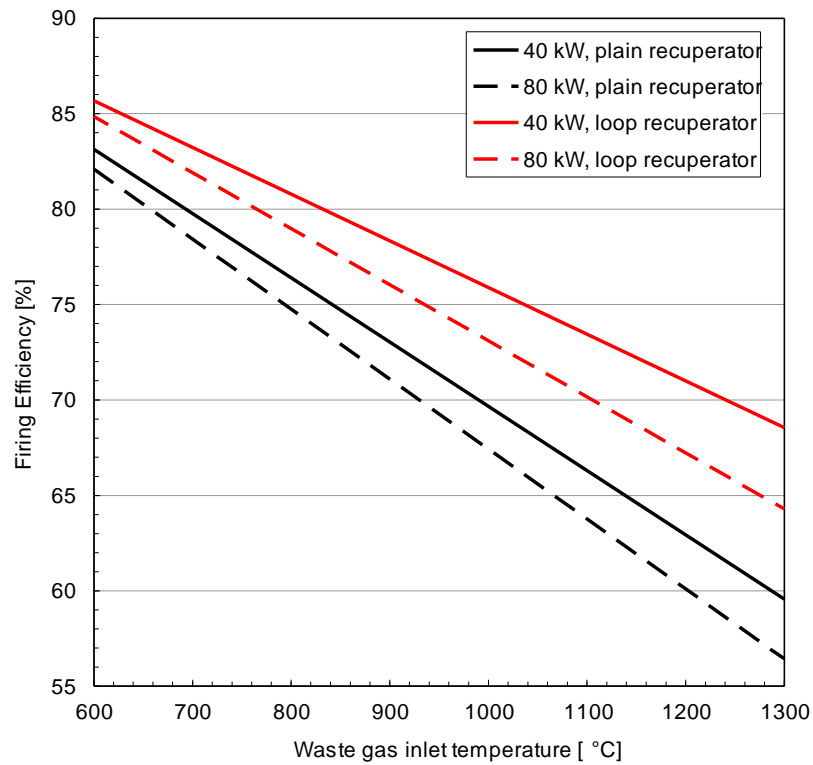


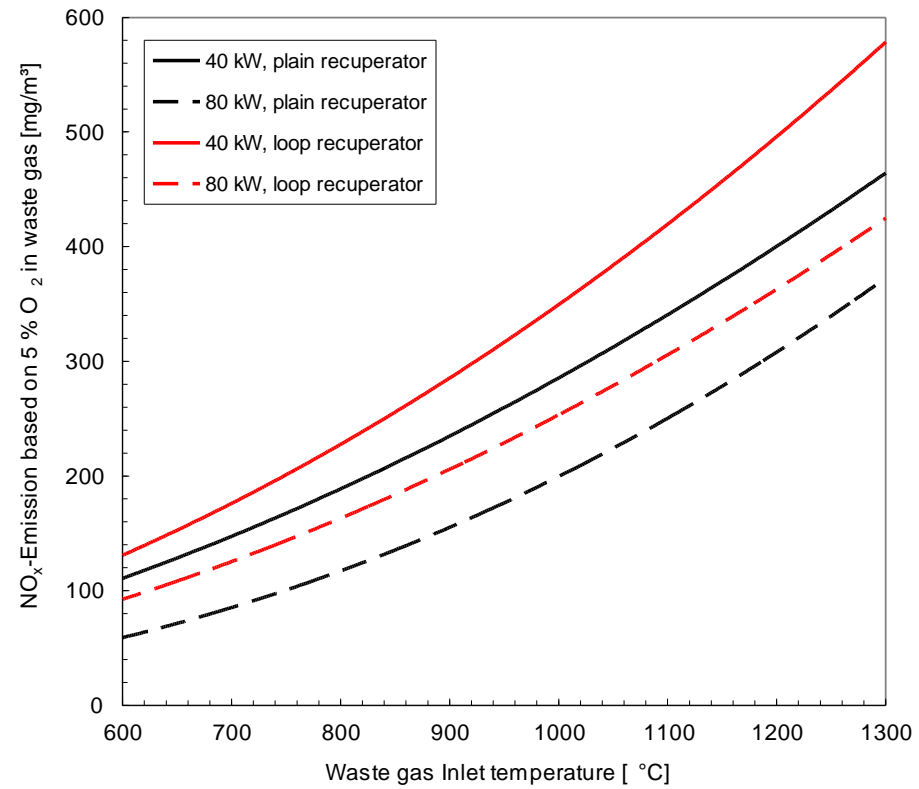
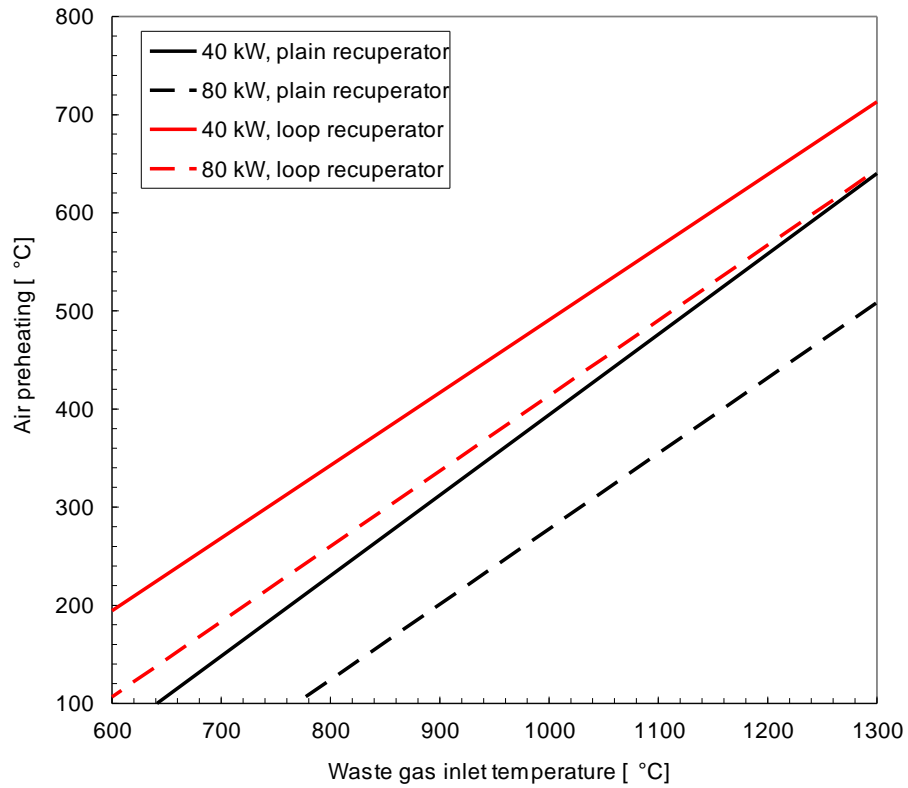
Plain heat exchanger



heat exchanger with Geometry 1

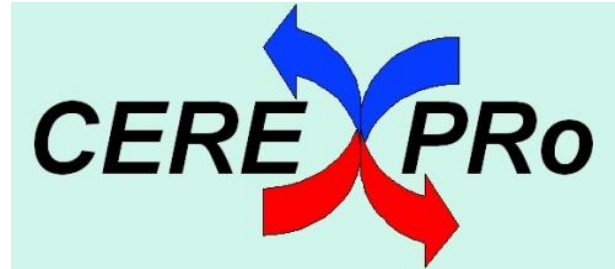






- ✓ Loop structure improved heat exchange and increase pressure drops
- ✓ Loops were produced with cheap textile techniques and converted into ceramics with the replica method
- ✓ Keeping loop geometry was difficult
- ✓ Loops were bonded to a qualified Si-SiC component
- ✓ In respect of plane heat exchangers, the firing efficiency was increased by 7-9 % depending on the waste gas inlet temperature
- ✓ NOx emissions were higher with the loops solution
- ✓ Tube handling was difficult because of the loops strength

Acknowledgements



The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 227551 (Project CEREXPRo).

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materials properties

process simulation

materials properties

experiments set up

thermo fluid dynamics

characterization

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