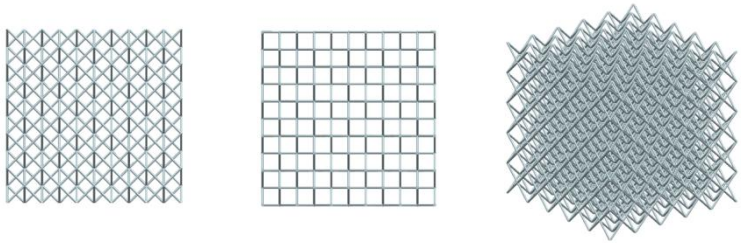
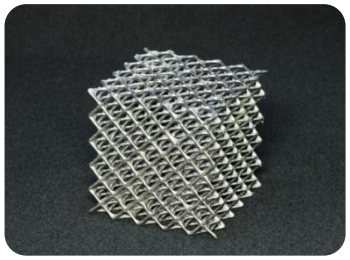
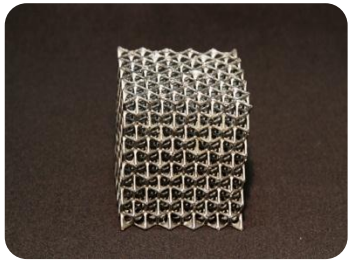
Porous Ceramics for CSP Applications







"New opportunities to increase solar absorber efficiency"

Sandro Gianella

Lugano, 26th June 2013

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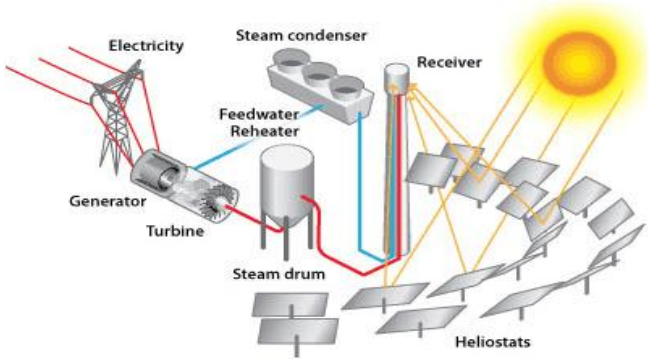
- High temperature solar receivers
- State of the art volumetric receivers
- Optimization opportunities
- Conclusions

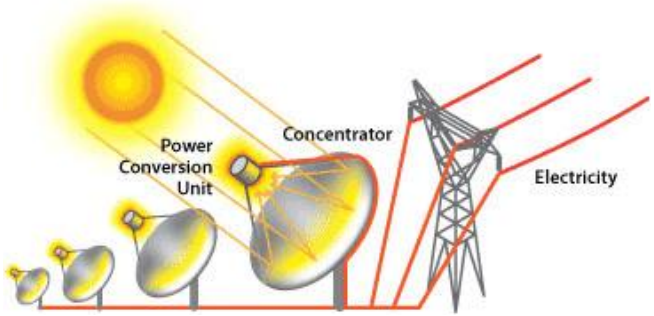
High temperature solar receivers

High temperature solar receivers

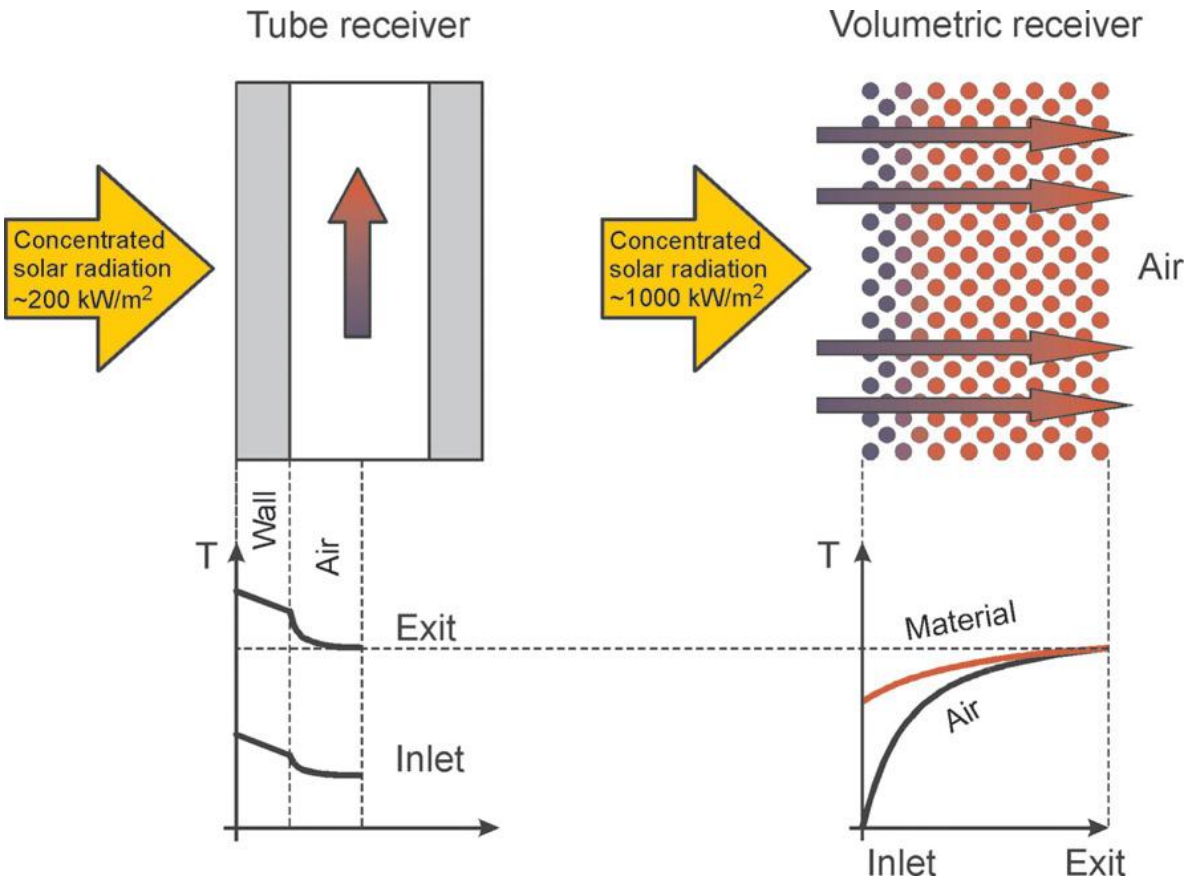
Solar tower



Dish



High temperature solar receivers

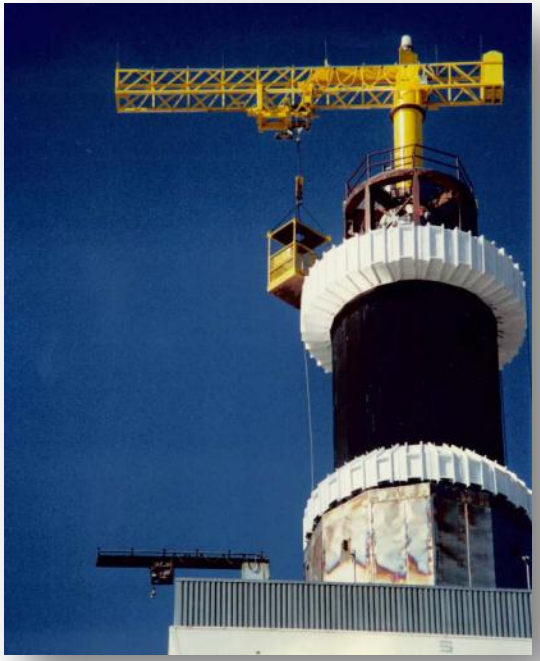


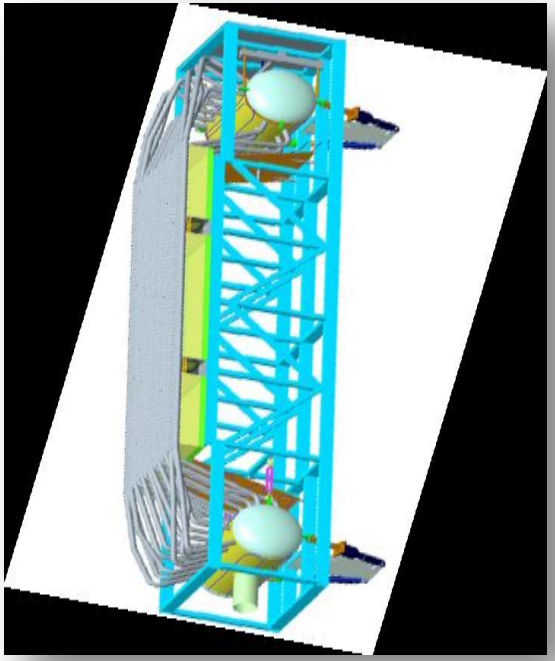
T. Fend, High porosity materials as volumetric receivers for solar energetics, Optica Applicata, Vol. XL, No. 2, 2010

High temperature solar receivers

Tube receivers

- Metallic tubes (special alloy)
- Max. 650°C flow temperature
- Tube outside temperature < 900°C

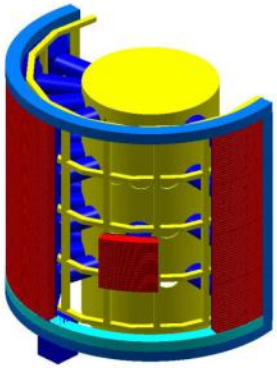




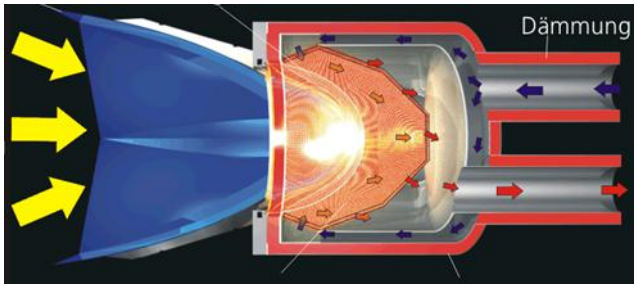
Solar Two in Daggett, California, 10-MW solar thermal electric power plant

High temperature solar receivers

Volumetric receiver

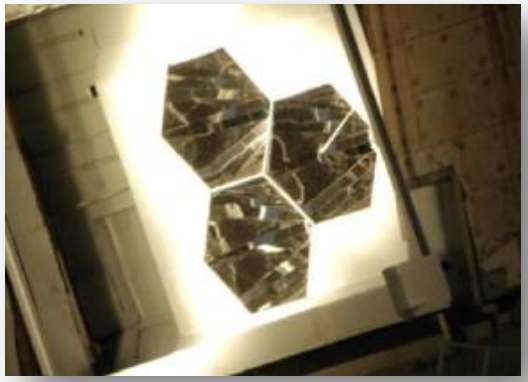


Open volumetric receiver HiTRec, DLR



Closed (pressurized) volumetric receiver
REFOS, DLR and CIEMAT, Spain

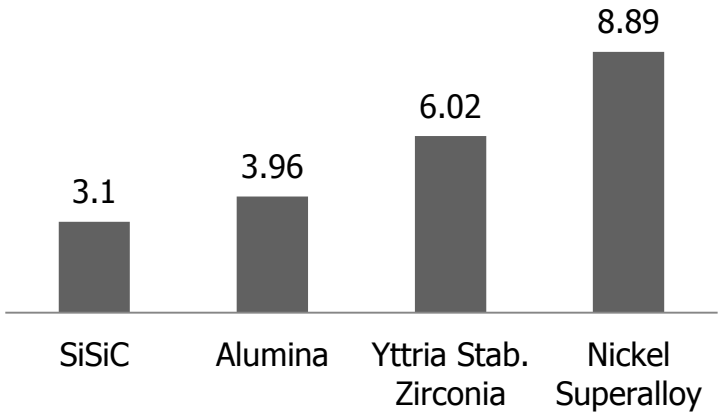
Implementation, KAM, Jülich



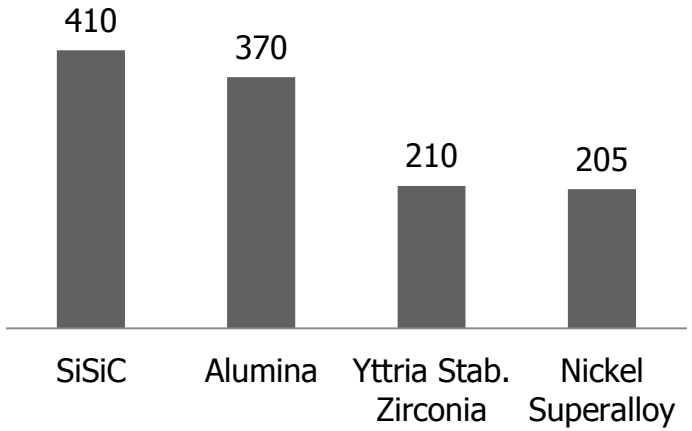
Implementation, Plataforma Solar de Almeria, Spain

State of the art volumetric receivers

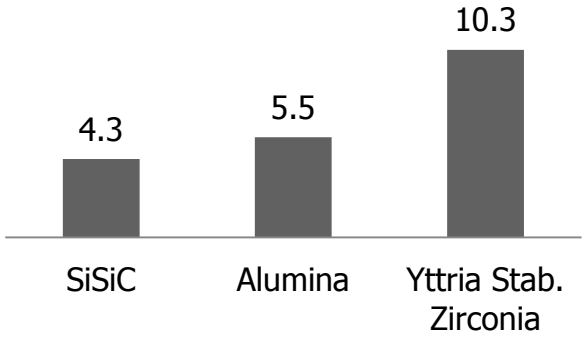
State of the art volumetric receivers



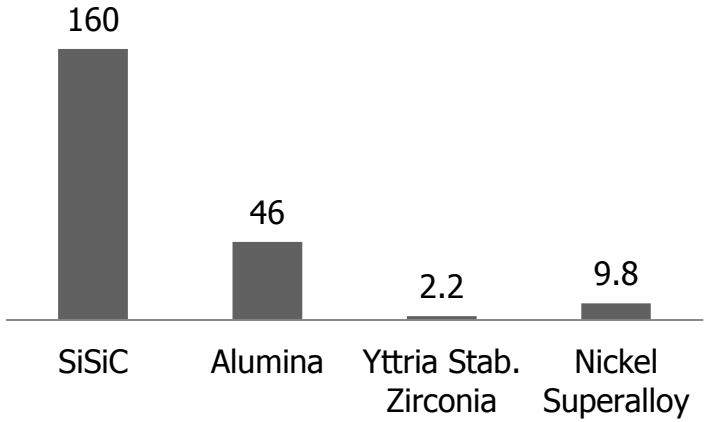
Density [g/cc]



Modulus of elasticity [GPa]



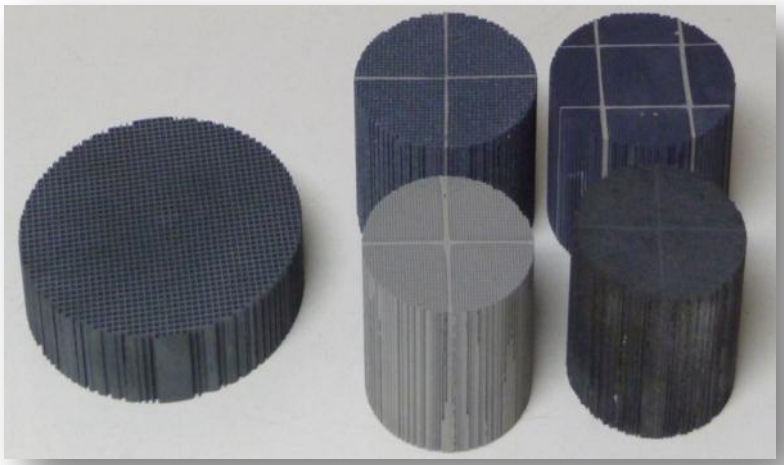
CTE linear at 25°C [µm/m-°C]



Thermal conductivity [W/m-K]

State of the art volumetric receivers

Honeycomb



Silicon carbide honeycomb, first commercial open volumetric receiver material, Saint Gobain

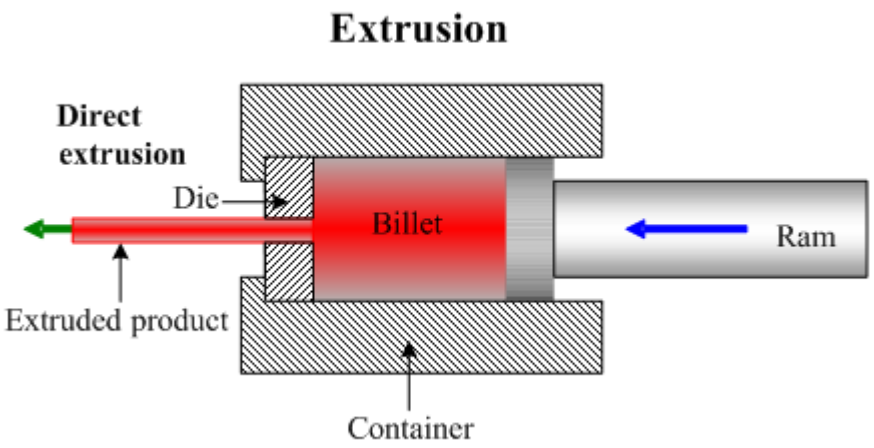
State of the art volumetric receivers

Stobbe SiSiC receivers

- Up to 1000°C air temperature achieved
- 80% efficiency from solar to air
- 2-dimensional flow
- Mass production

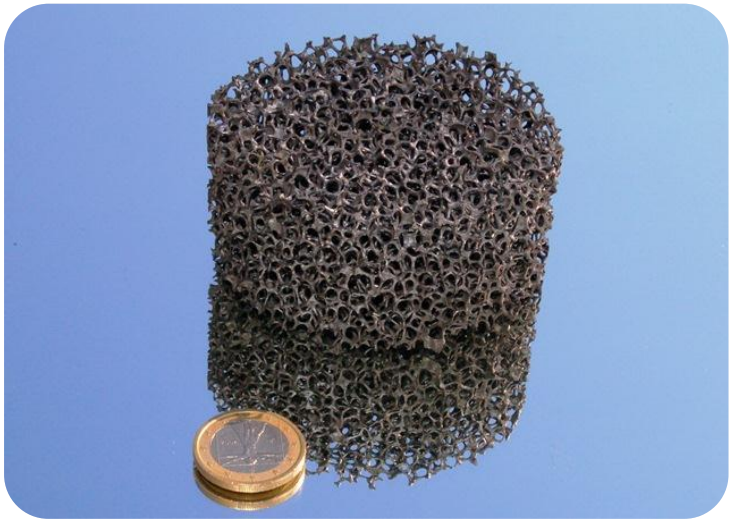
State of the art volumetric receivers

Extrusion



State of the art volumetric receivers

Foam



SiSiC foam, Erbicol SA, 3-dimensional flow

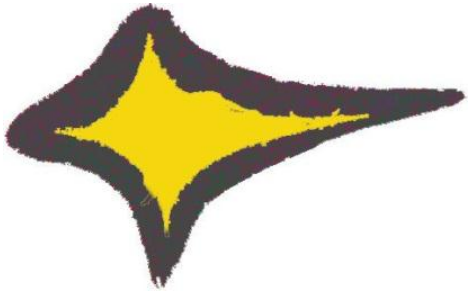
State of the art volumetric receivers

Template

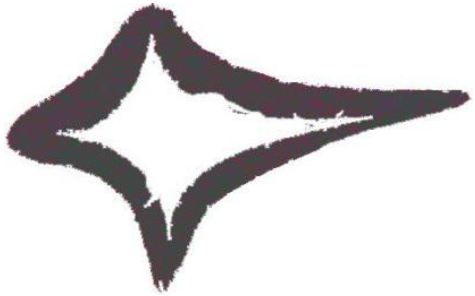
Finisched product

Coating

LSI



Pyrolysis



Green body

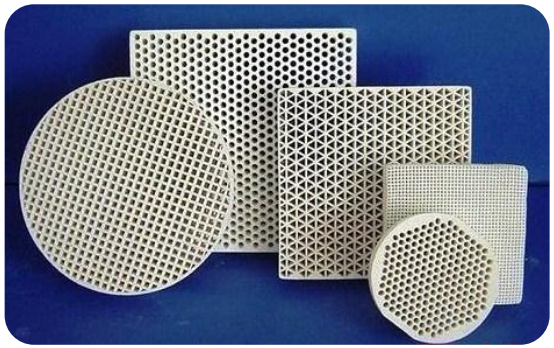
Ceramic intermediate

Optimization opportunities

Optimization opportunities

Honeycombs

- Cell size
- Cell shape
- Wall thickness
- Overall product shape

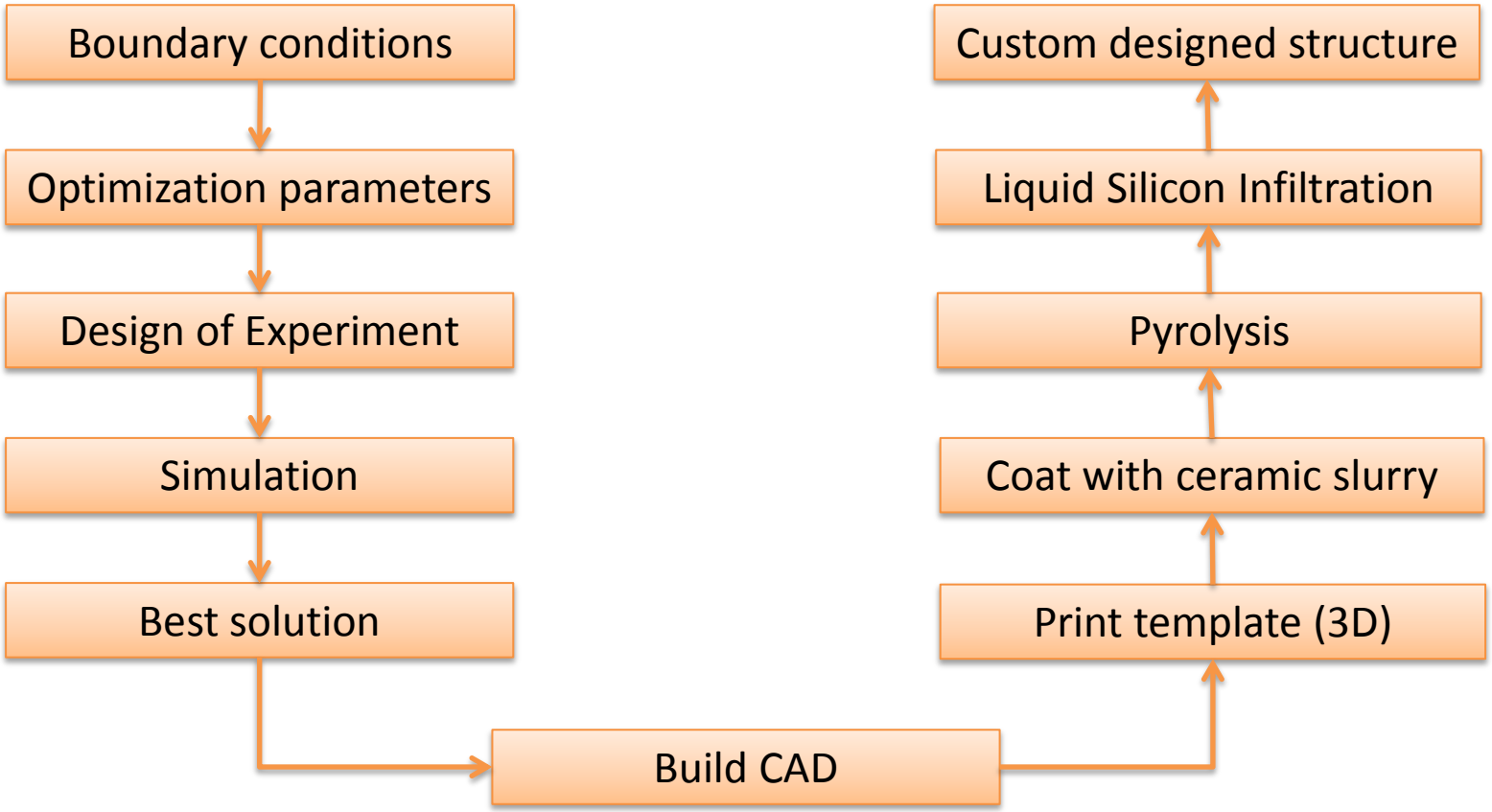


Foams

- Cell size
- Cell orientation
- Strut thickness
- Overall product shape

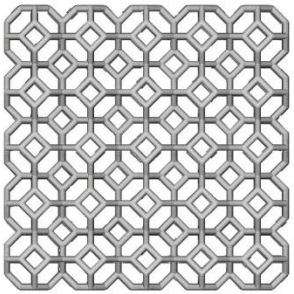
Optimization opportunities

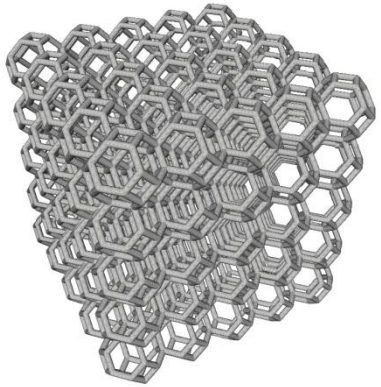
New approach

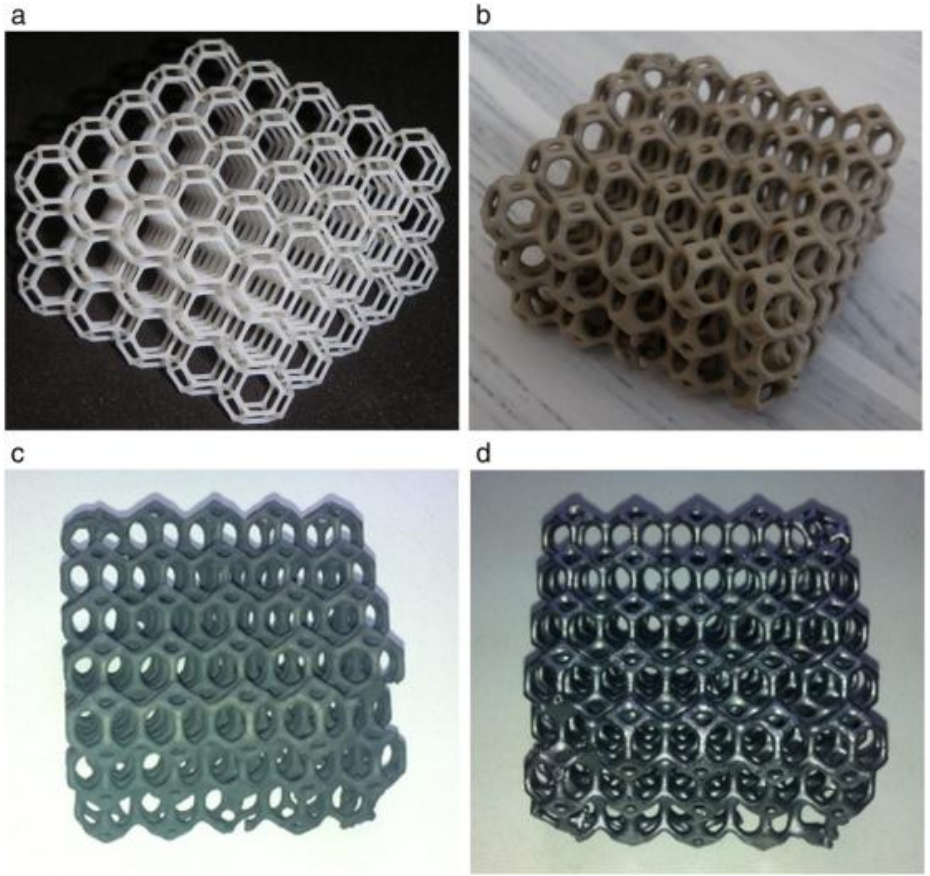


Optimization opportunities

Tetrakaidecahedron



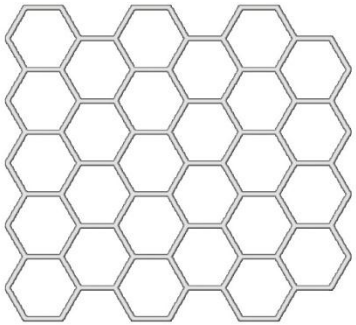


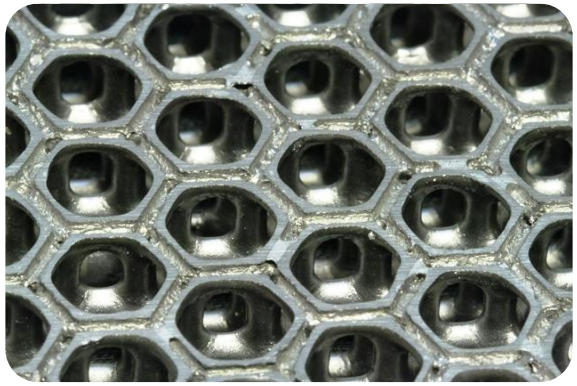


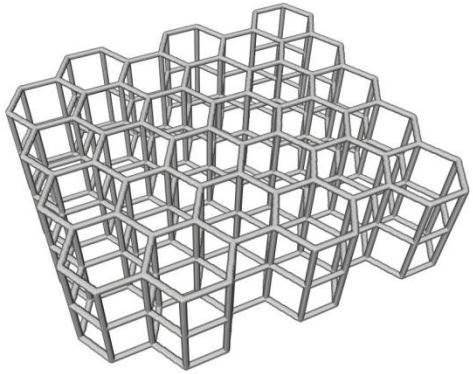
A. Ortona, C. D'Angelo, S. Gianella, D. Gaia, Cellular ceramics produced by rapid prototyping and replication, Materials Letters, Volume 80, 1 August 2012, Pages 95–98

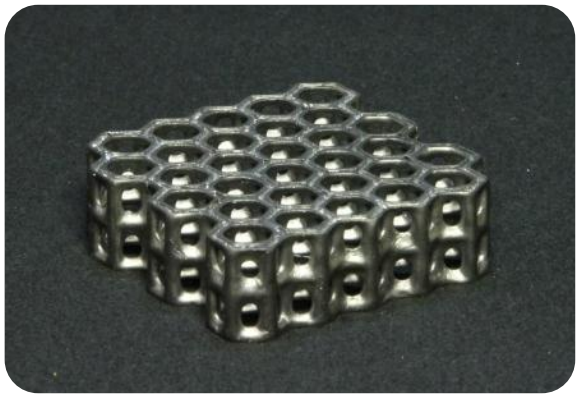
Optimization opportunities

Optimization for compression



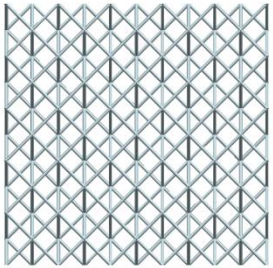


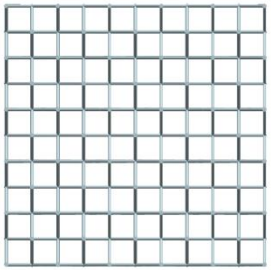


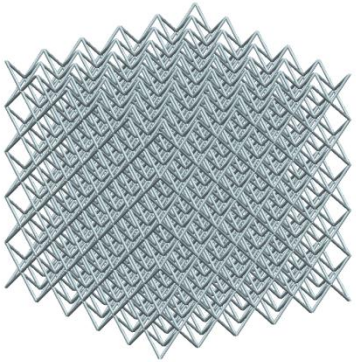


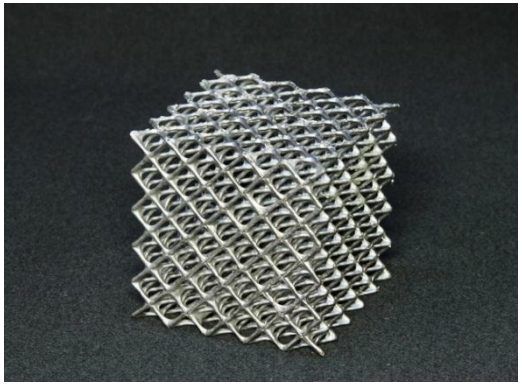
Optimization opportunities

Preferential flow direction

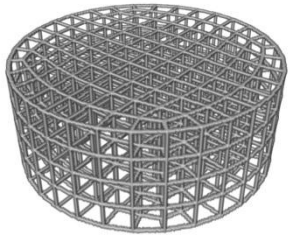


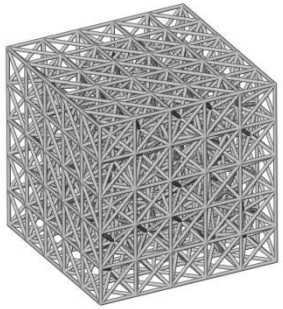


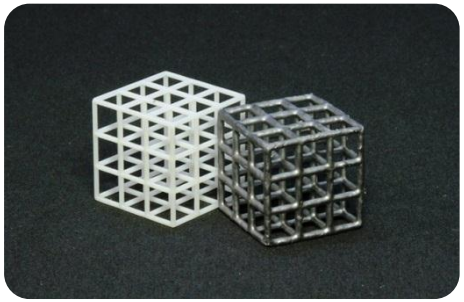


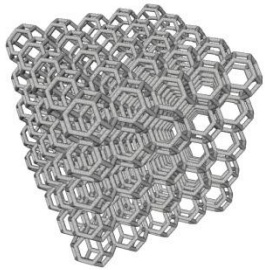


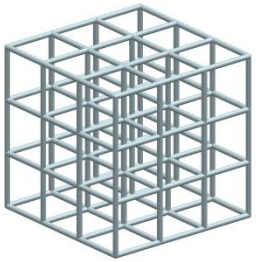
Optimization opportunities

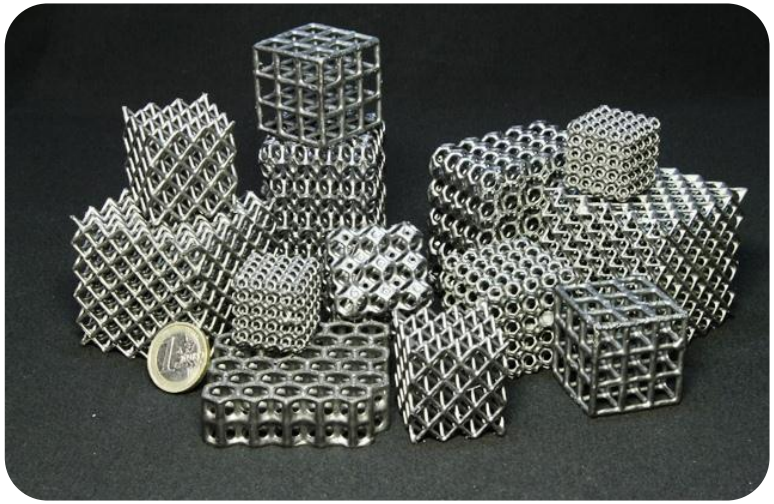


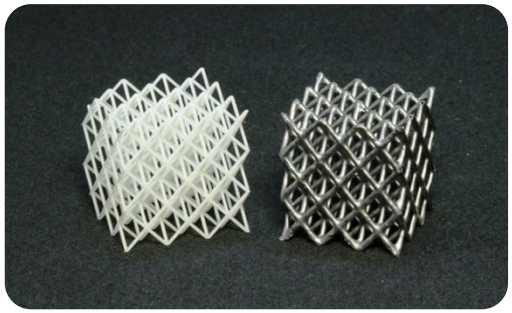


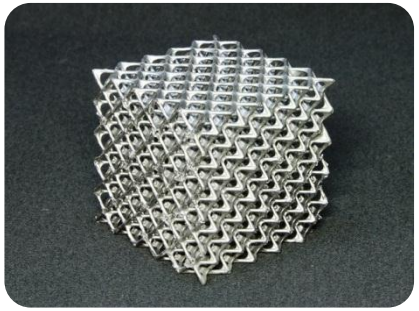












Conclusions

Conclusions

Engineered ceramics offer:

- Unlimited freedom
- Higher performance
- Duplicable
- Better quality control and standardization

Thanks

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Porous Ceramics Dept.
Erbicol SA

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