Synchrotron tomography on zinc and aluminium foams

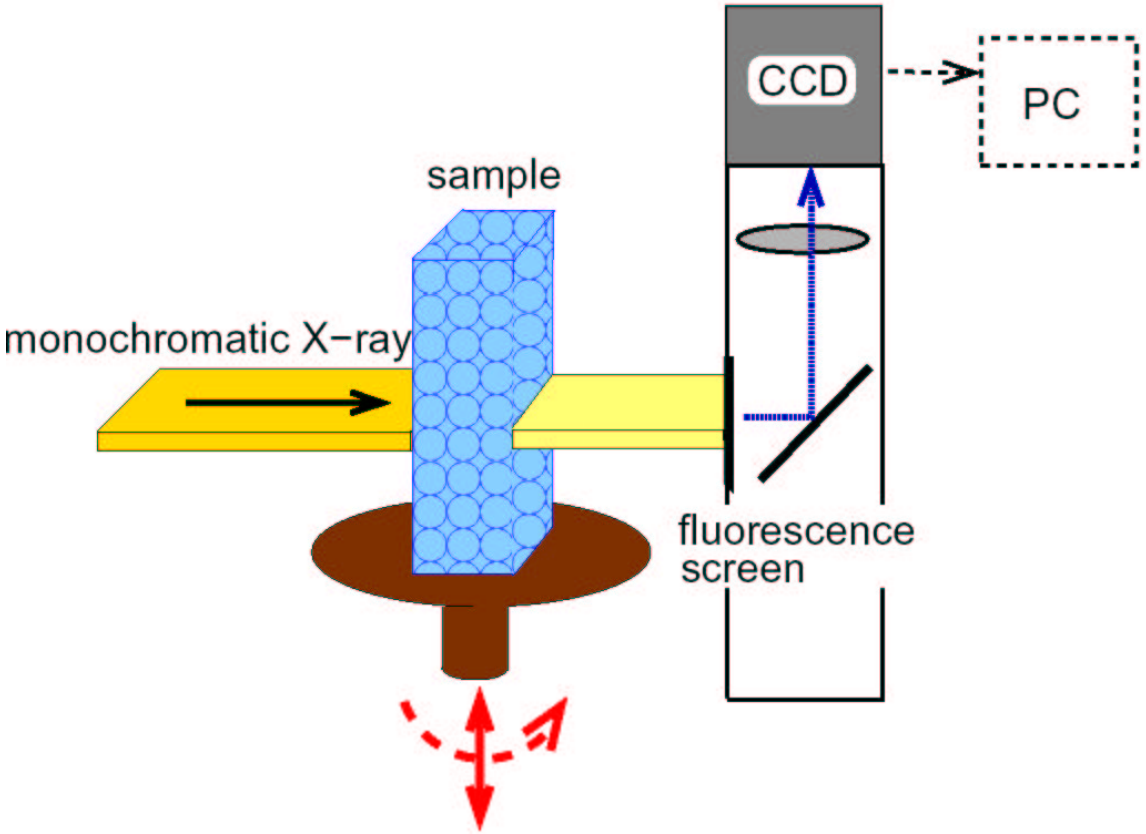
A. Rack, A. Haibel, B. Matijasevic, J. Banhart

Hahn-Meitner-Institut Berlin, Germany

Content

- zinc (powder compact foaming process) and aluminium foams (cast solid precursor)
- pure zinc with blowing agent TiH_2 or ZrH_2
- aluminium alloy (AlSi10Mg) with blowing agent TiH_2 and SiC particles (University of Cambridge)
- investigation zinc foam vs. aluminium foam
- possible correlation of pore structure and particle formation in aluminium foam

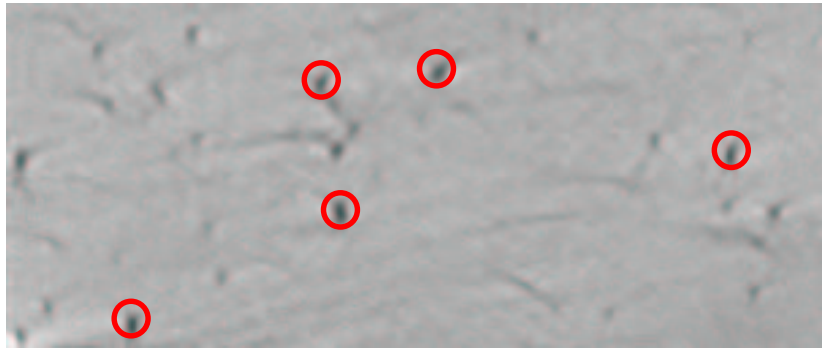
Synchrotron tomography

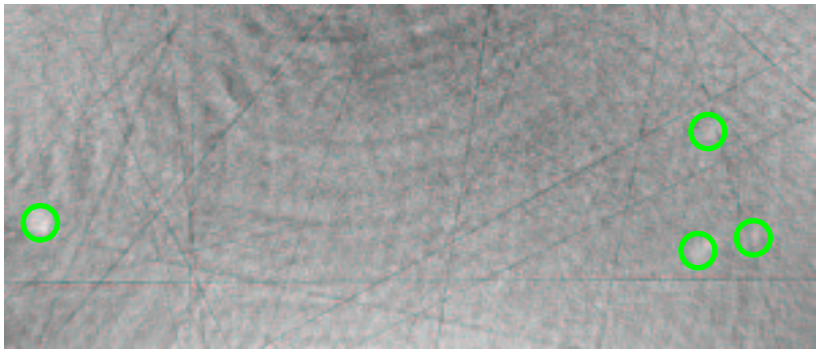


- 180° rotation of sample in 720 steps
- reconstruction with filtered backprojection
- used resolutions: 5 µm and 11 µm
- X-ray energies: 25 keV (Al foam) and 60 keV (Zn foam)

tomographic facility at BAMline
(BAM - Federal Institute for Materials Research and Testing)
located within BESSY II
(Berlin electron storage ring company for synchrotron radiation)

Attenuation coefficients

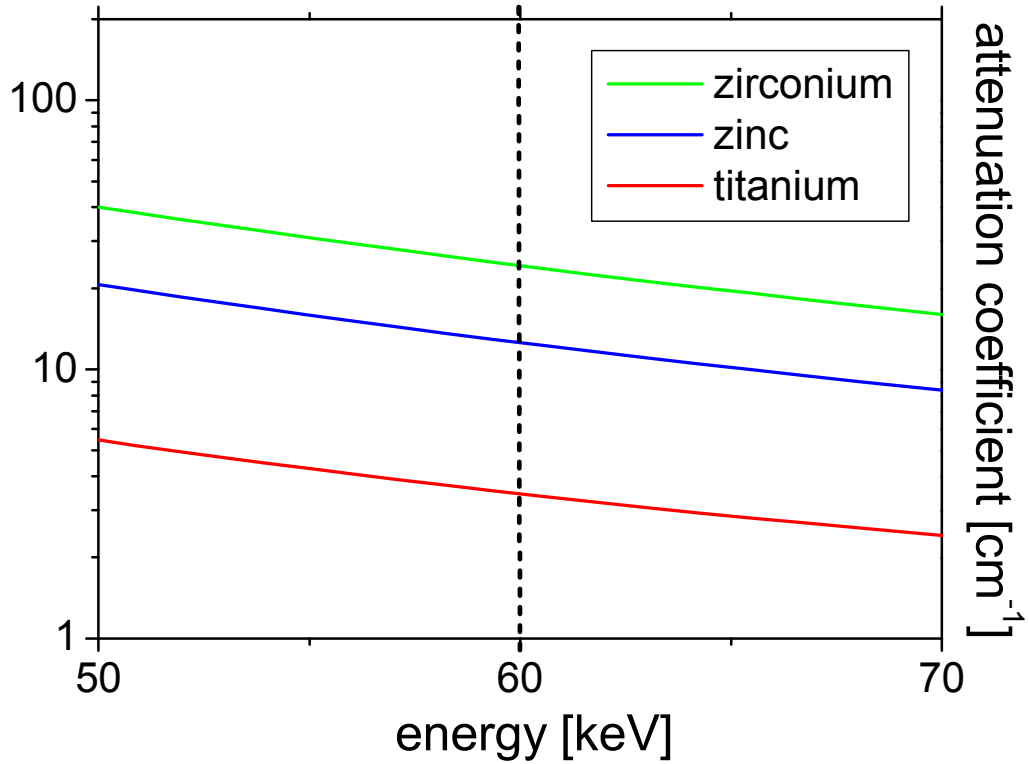




$Zn+TiH_2$
bulk

precursor:

0.50 vol%



$Zn+ZrH_2$
bulk

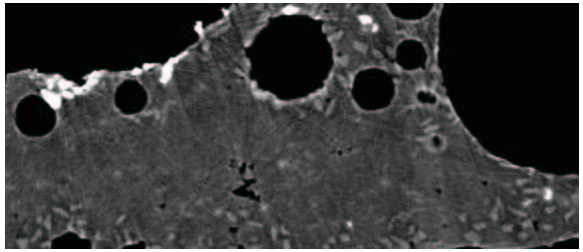
precursor:

0.66 vol%

3D image analysis

Separation

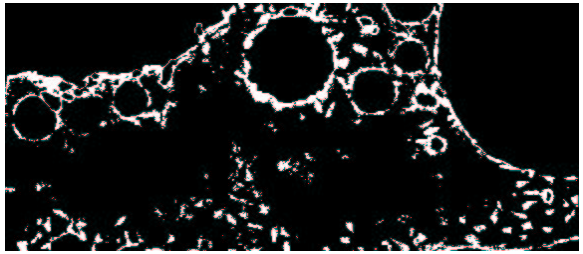
Al foam



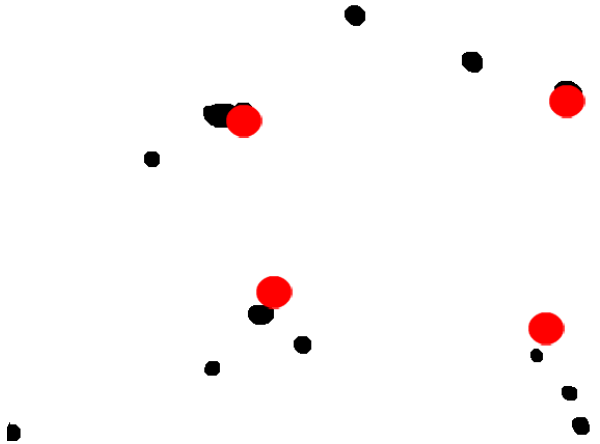
pores

TiH_2

SiC

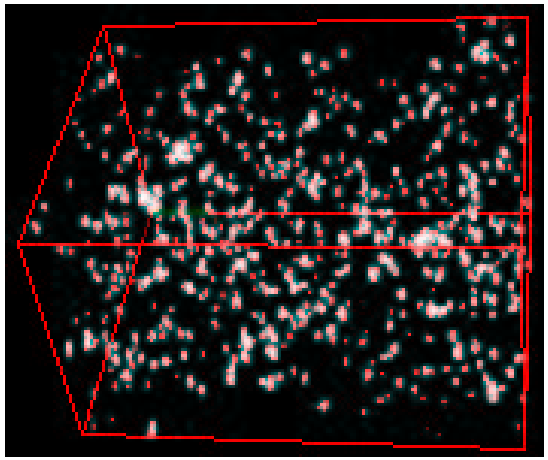


pore-SiC correlation

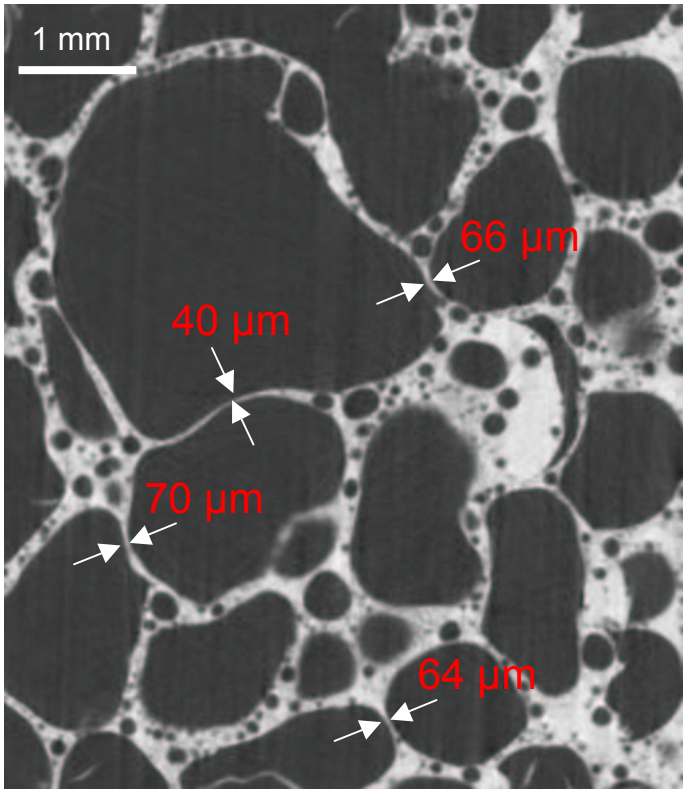


Ohser, Helfen et al.

3D TiH_2 distribution



Zinc foam - critical thickness of cell walls

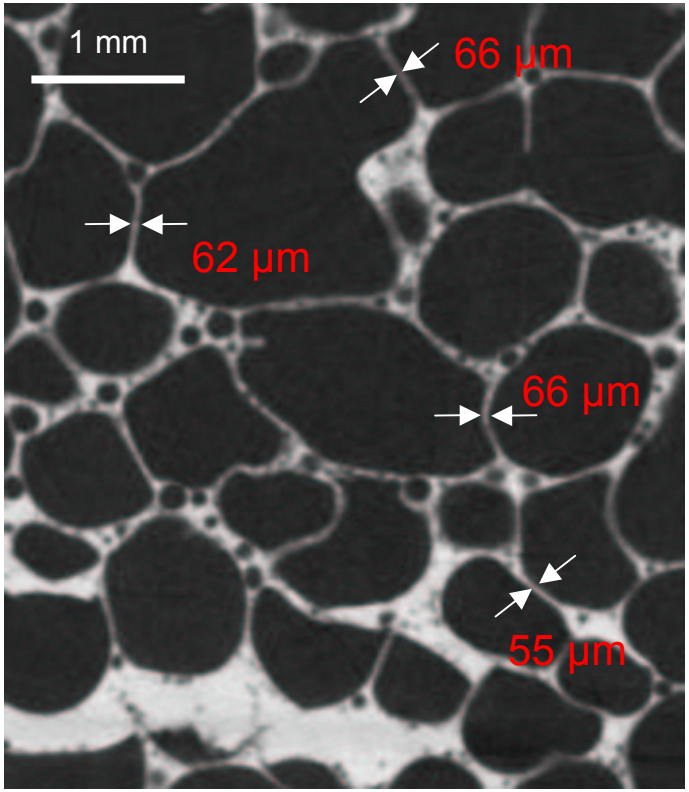


η_{melt}(Al)

1.25 mN s/m^2

η_{melt}(Zn)

3.75 mN s/m^2



TiH_2 size > 28 µm
porosity 72%

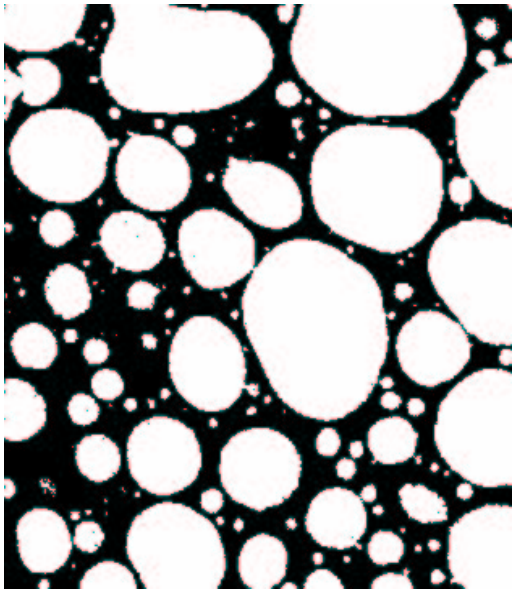
walls: 40 µm

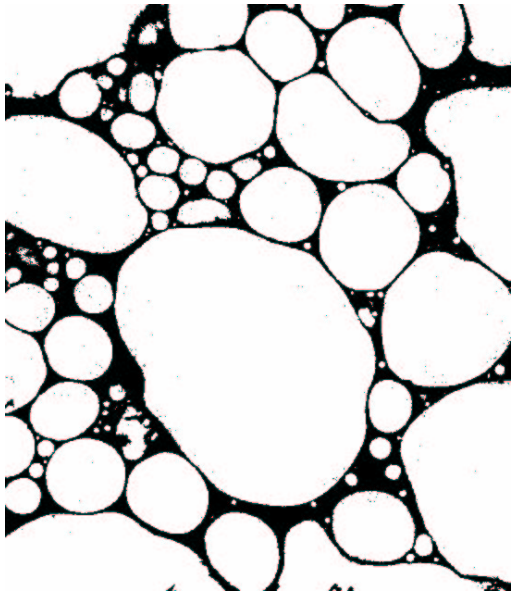
Al foam walls:
50 ± 10 µm
Banhart,
Stanzick et al.

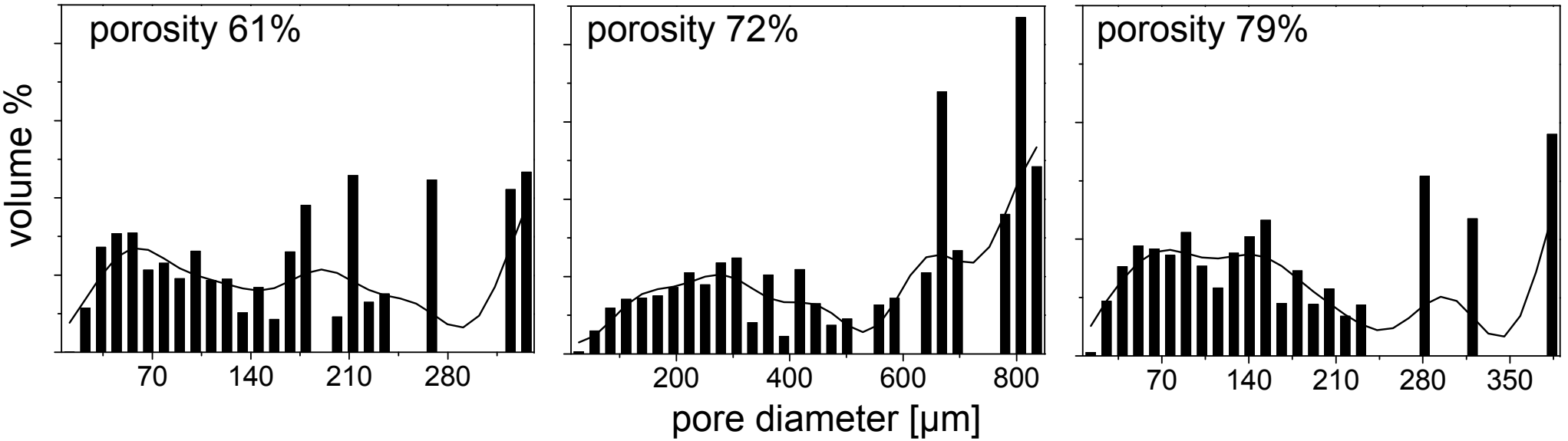
TiH_2 size < 28 µm
porosity 73%

walls: 50 µm

Zinc foam – pore size distribution

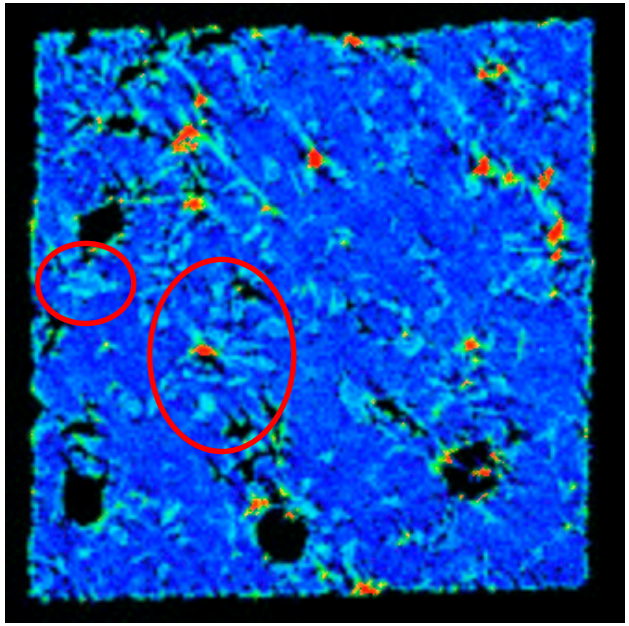




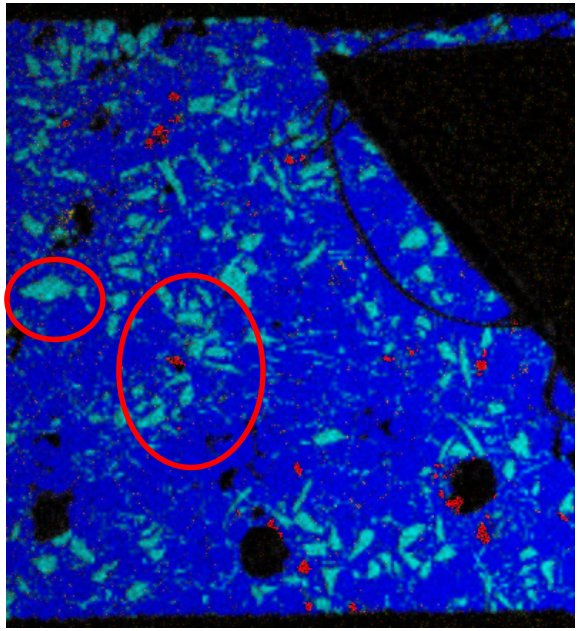


Aluminium foam - tomography vs. EDX vs. light microscopy

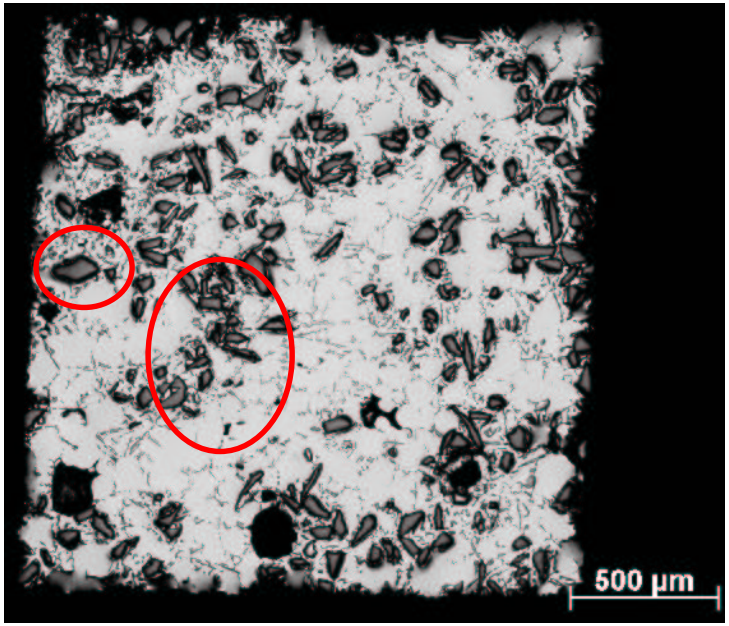
verification of the tomographic results by comparing a 2D-slice with the results of other measurement methods



tomographic slice



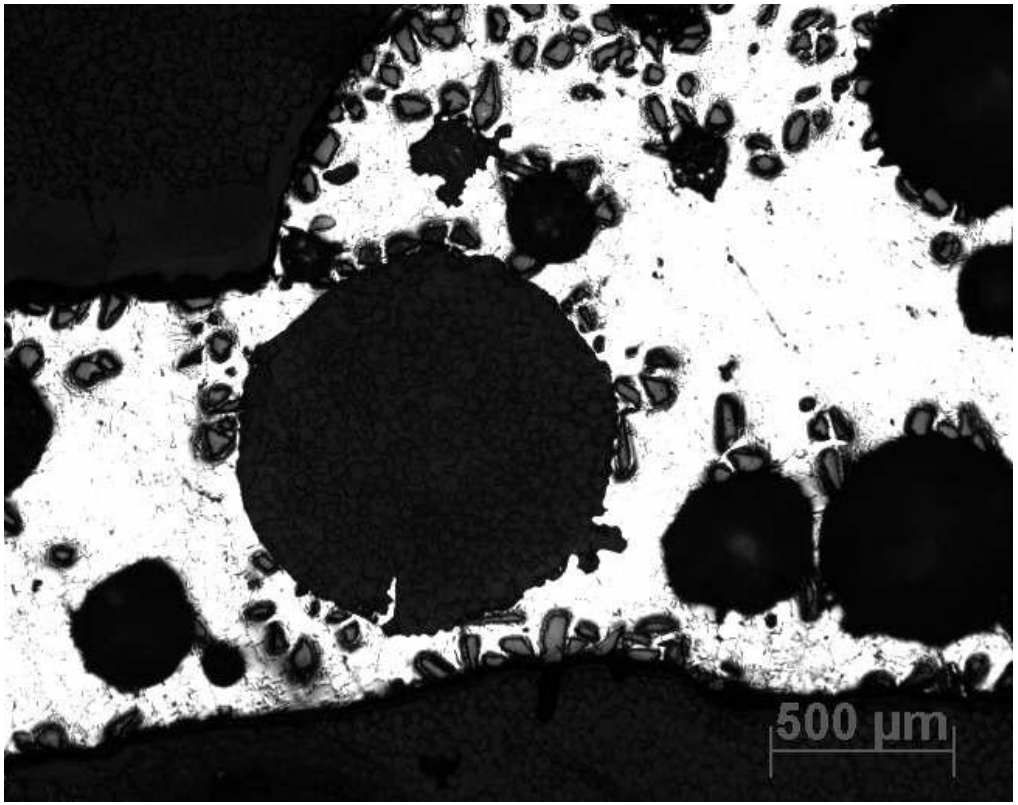
SEM + EDX
(composition analysis)



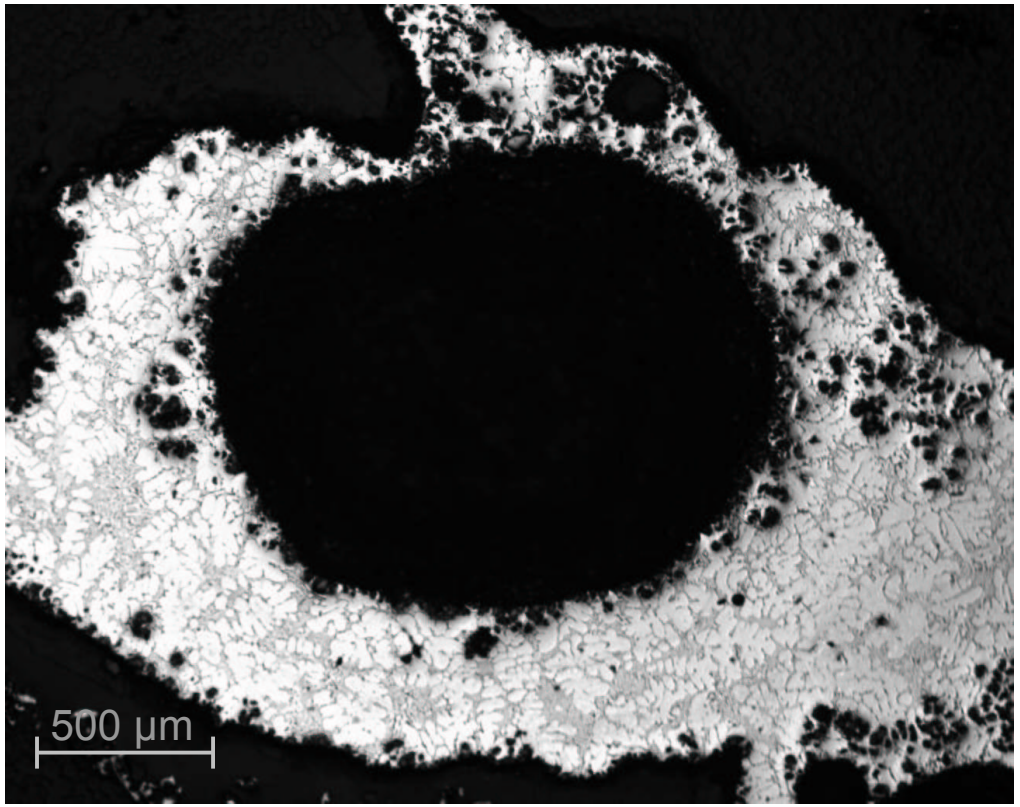
light microscopy

Aluminium foam – light microscopy

70 µm particles



13 µm particles

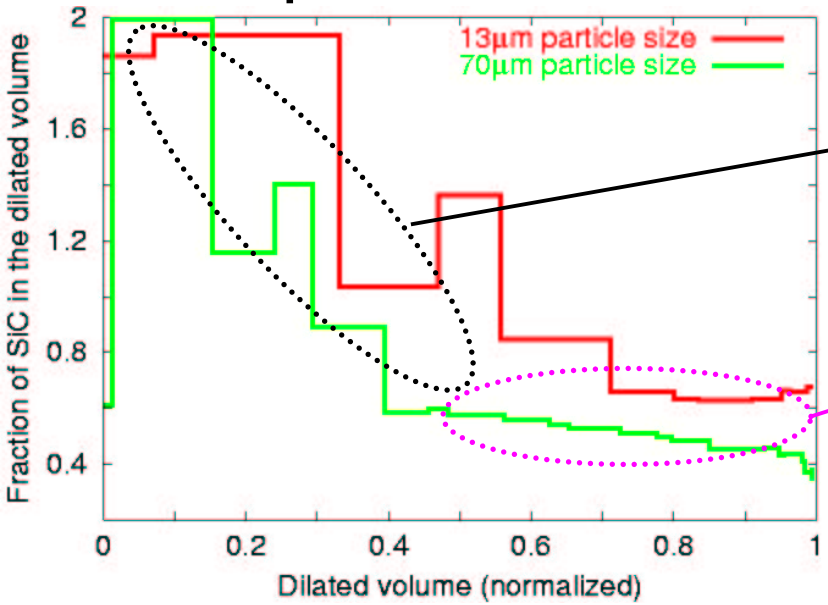


particle formation around the pores and on the wall surfaces

2D destructive measurement method

Aluminium foam – pore-SiC correlation

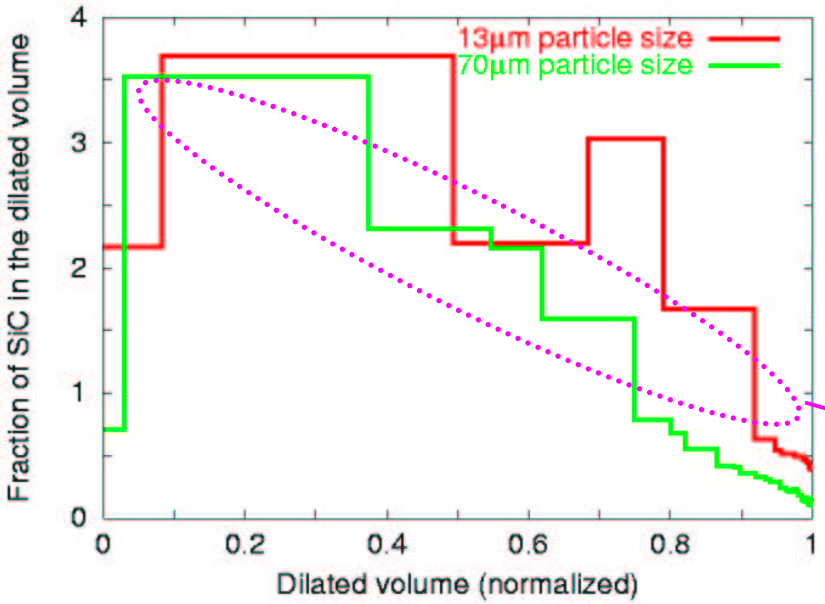
precursor
(initial pores)

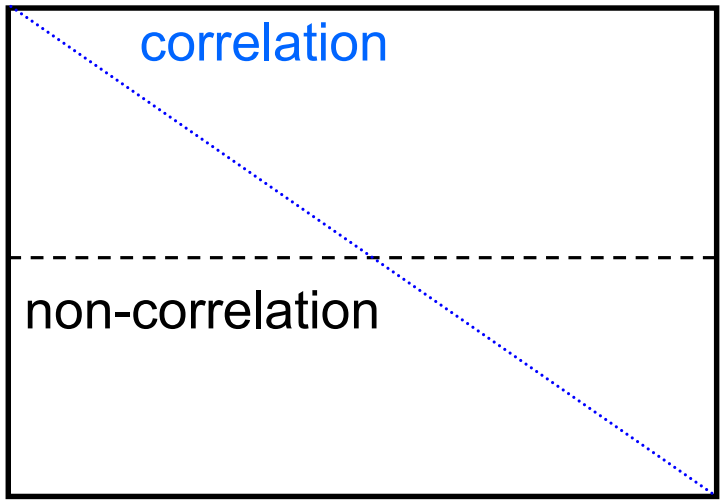


particle accumulation at the initial pore surfaces which caused by preparation

homogeneous particle distribution

foamed





pore and particle formation are correlated

Summary

- zinc and aluminium foams investigated with synchrotron tomography
- broad pore size distribution in pure zinc foam: qualitative agreement with 2D observations
- critical cell wall thickness for pure zinc within the same range as for aluminium foams
- in aluminium foam SiC particles are located next to pores

END

Aluminium vs. Zinc

	Aluminium	Zinc
ρ_{melt}	2.48 g/cm^3	6.57 g/cm^3
ρ	2.70 g/cm^3	7.13 g/cm^3
T_{melt}	660 °C	419 °C
η_{melt}	1.25 mN s/m^2	3.75 mN s/m^2
γ_{melt}	914 mN/m	782 mN/m
solubility H_2	0.69 (660 °C)	< 0.002 (516 °C)