

Titanium Zirkonium as window material for pressure cells

A material study

Henrich Frielinghaus

History:

Ingot bought from Eddy Lelièvre-Berna: May 2013

Ingot size: 190mm diameter, 400mm long

Material Characterization by FZJ: May-September 2013

Stability calculations for different cell constructions

Feedback: 5000 bar for existing pressure cell

(same as sapphire)

2500 – 4000 bar for specific NSE construction

Data sheet from Eddy:

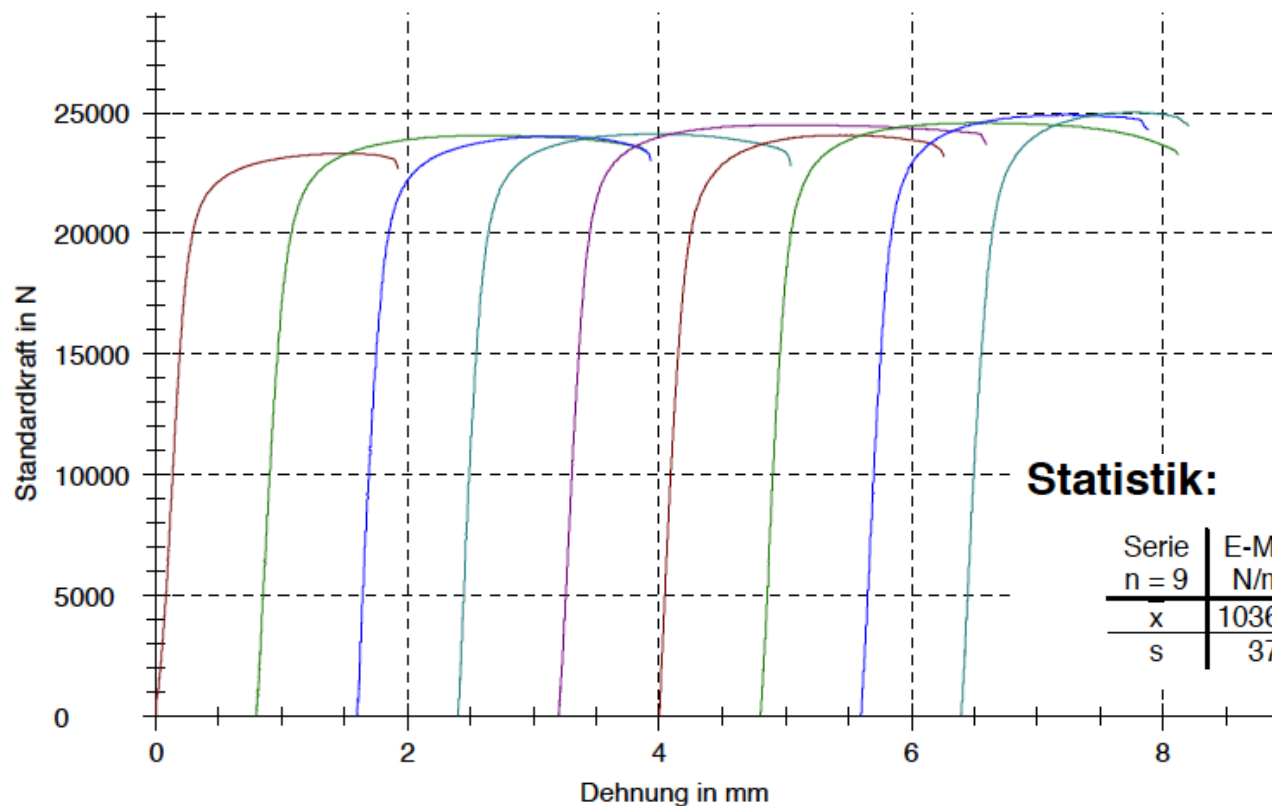
Two room temperature tensile tests were conducted. Results from which are summarized below:

PIECE ID	0.2% PS (ksi)	UTS (ksi)	%EL	%RA
V8501-1	108.2	129.3	10.0	14.4
V8501-2	106.6	112.1	0.6	0.4
V8502-1	109.3	132.3	9.7	23.1
V8502-2	111.5	133.9	6.5	11.9
V8503-1	105.1	124.9	12.9	30.2
V8503-2	102.1	122.5	7.8	21.4

V8504-1	105.8	127.1	10.0	21.1
V8504-2	108.8	131.9	9.0	20.1
V8505-1	106.0	126.3	10.7	21.1
V8505-2	102.7	123.3	10.2	18.5

Ergebnisse:

Legende	Nr	Durchmesser d0 mm	S0 mm ²	L0 mm	E-Modul N/mm ²	Rp 0,2 N/mm ²	F max N	Rm N/mm ²	A %
	1	5,97	27,99	30,32	99442,8	726,42	23317,56	833,00	5,44
	2	5,99	28,18	30,35	96799,9	712,22	24074,24	854,30	9,31
	3	5,98	28,09	30,33	103339,3	722,74	24045,38	856,13	6,93
	4	5,99	28,18	29,63	107780,8	720,69	24134,01	856,42	8,20
	5	5,99	28,18	30,29	106148,7	740,85	24508,69	869,71	10,39
	6	5,99	28,18	30,18	102622,8	722,70	24087,49	854,77	6,72
	7	6	28,27	30,43	108451,2	734,61	24592,73	869,79	10,13
	8	6	28,27	30,27	104139,6	745,77	24916,52	881,24	6,71
	9	5,99	28,18	31,53	103967,4	753,17	25026,98	888,11	4,91



Statistik:

Serie n = 9	E-Modul N/mm ²	Rp 0,2 N/mm ²	Rm N/mm ²	F max N	A %
x	103632,5	731,02	862,61	24300,40	7,64
s	3749,5	13,40	16,53	523,40	1,98

The existing pressure cell for neutron scattering on KWS (sapphire windows):

What high pressure cells exist in other facilities :

At PSI 5000 bar:

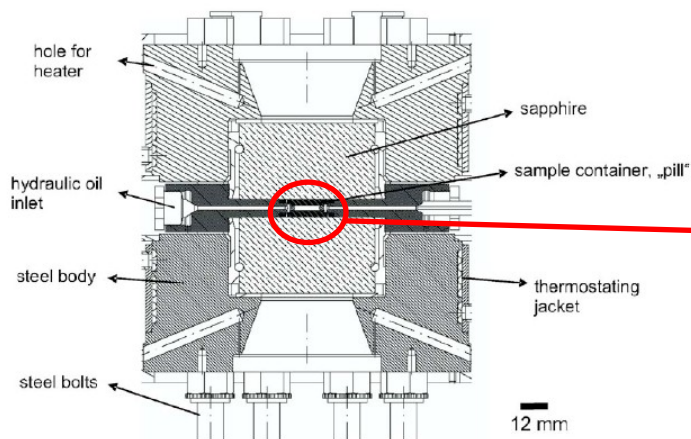


FIG. 1. (Color online) Middle cut through the high pressure cell.

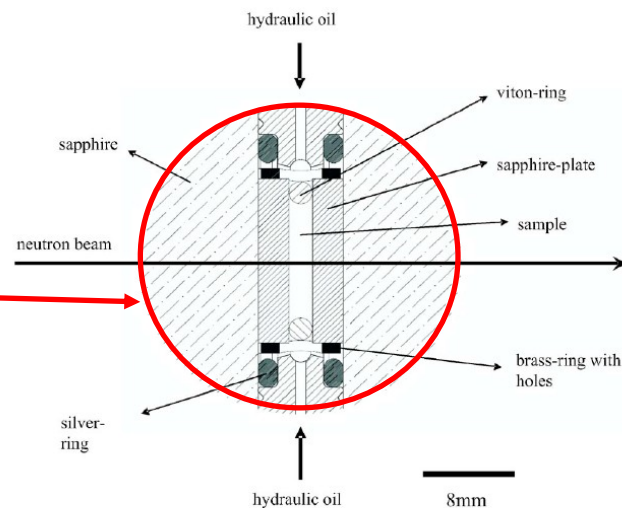


FIG. 3. (Color online) Shown is an inner circular section of the cell as in Fig. 1 with details of the sample container (pill). The cut is along the holes of the brass ring to illustrate where the hydraulic oil can transmit the pressure via the Viton O-ring.



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A high pressure cell for small angle neutron scattering up to 500 MPa in combination with light scattering to investigate liquid samples

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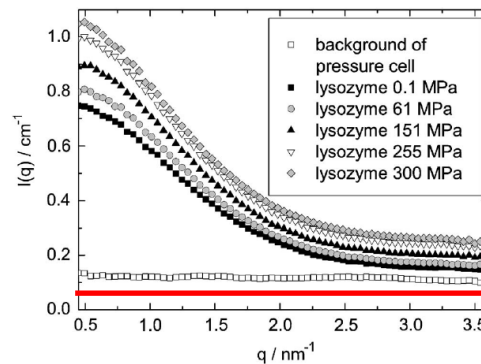
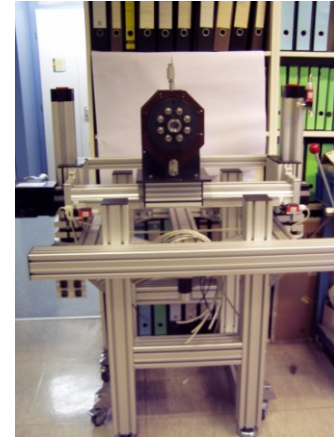
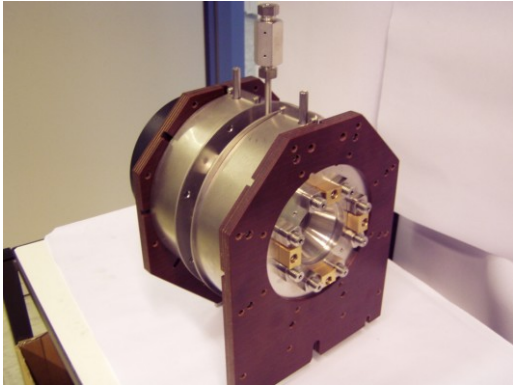


FIG. 7. SANS results for lysozyme in D_2O as a function of pressure as indicated. Also shown for comparison is the background of the high pressure cell. It shows no q dependence and amounts to about 0.12 cm^{-1} .

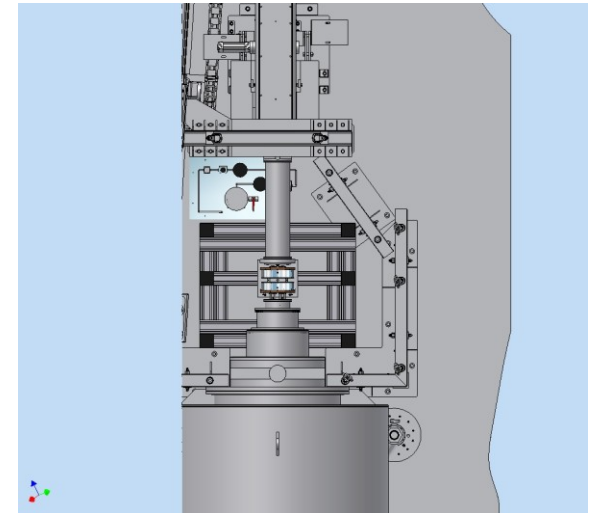
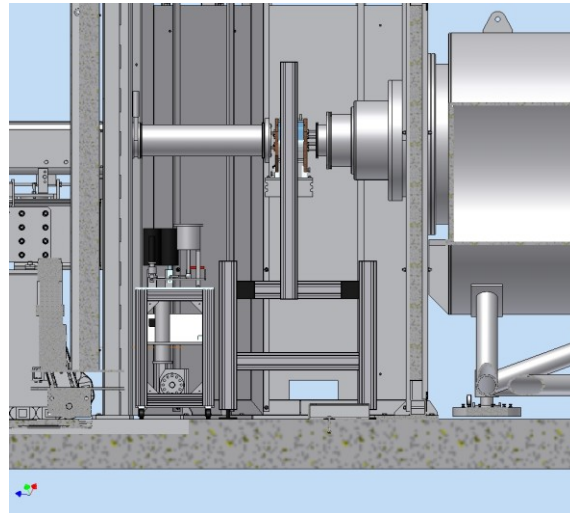
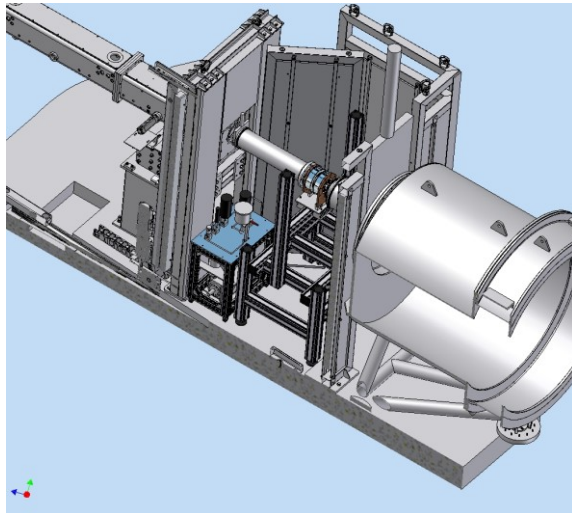
Level for D_2O : $0,03 \text{ cm}^{-1}$
Level for deuterated phosphate buffer : $0,05 \text{ cm}^{-1}$

Existing pressure cell for neutron scattering on KWS:



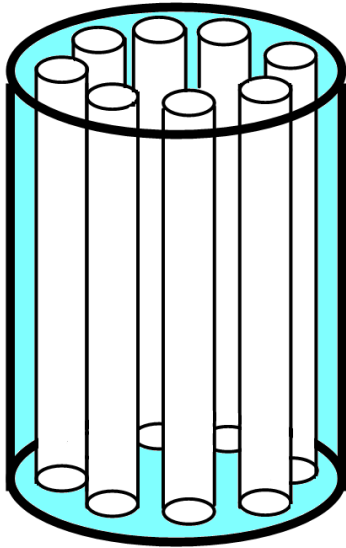
From H. Feilbach

We are using Inconel : a non magnetic material (for polarization analysis and NSE)



From M. Heiderich

The pressure cell for spin echo neutron scattering on J-NSE (originally made from sapphire):



- Building a high pressure cell using sapphire block able to sustain 7000 bar : dynamics of pressure-unfolded protein investigated in the nanosecond timescale with Neutron Spin Echo spectrometer (Olaf Holderer)

Next Steps:

Measure SANS scattering from window (old pressure cell)

Optimize, manufacture NSE cylinder construction.

Discuss other options.

My feeling is: **The NSE pressure cell will not be the highlight.**

Take a look on in-situ Light Scattering option.