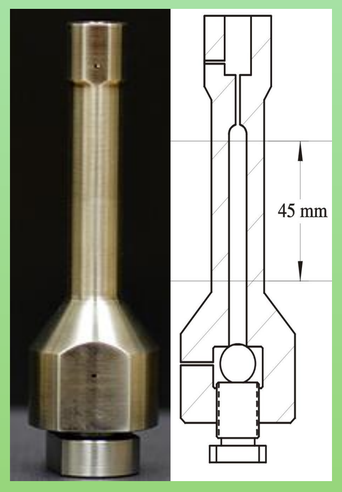
Hydrostatic High Pressure Capabilities at the NIST Center for Neutron Research

Juscelino B. Leão

NIST Center for Neutron Research. Gaithersburg, MD

The NIST Center for Neutron Research currently provides a series of pressure apparatus ranging to as high as 2.5 GPa that are specially designed for neutron spectroscopy. Most of the pressure equipment can be mounted in a variety of instruments throughout NCNR's facility, allowing for experimental flexibility and maximizing beam time use.

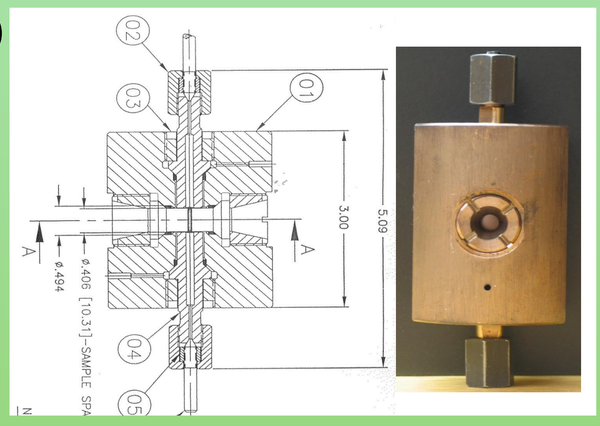
(a)
(c)



1.0 GPa Inert Gas Pressure Vessel

P_{max} = 1.0 GPa
1.5K < T < 350K
13-8Mo stainless steel construction
(No cobalt)
2.2 cm^3 total sample volume
1.5 cm^3 effective illuminated volume
25% neutron transmission at 2Å
Inert gases

(b)

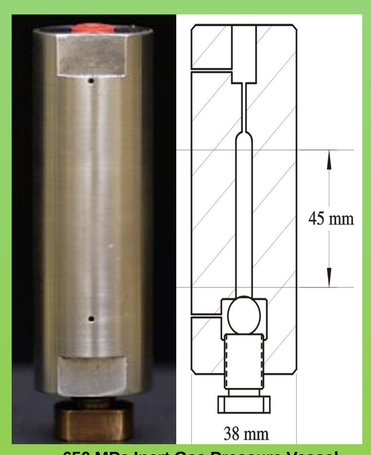


300 MPa Sapphire Window Pressure Vessel

P_{max} = 300 MPa
LN_2 < T < 350K
CuBe construction with sapphire windows
2.2 cm^3 total sample volume
Neutron beam cross-section area 0.3 cm^2
Beam divergence angle θ ≈ 15º
Inert gases

P_{max} = 650 MPa
1.5K < T < 300K
Aluminum 7075-T6 construction
1.5 cm^3 sample volume
.635 cm dia. x 5.08 cm sample illumination
60% Neutron Transmission at 2Å
Inert Gases

(a)
(b)
(e)



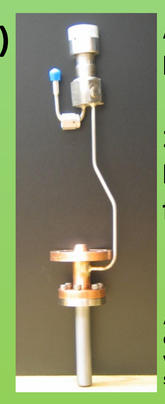
650 MPa Inert Gas Pressure Vessel

P_{max} = 200 MPa
LN_2 < T < 350K
S.S. Construction with sapphire windows
1.0 Cm^2 total sample cross section area
Adjustable sample thickness
Beam divergence angle θ ≈ 20º
Methane, CO_2, H_2 , inert gases, fluids

(b)

200 MPa Sapphire Window SANS Pressure Vessel

(d)

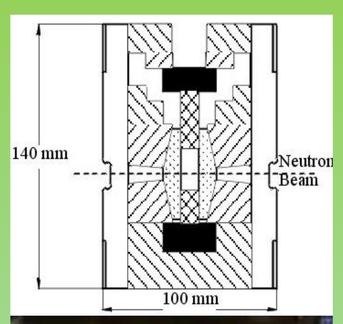


Air sensitive/gas loading
P_{max} = 1.4 MPa (V)
Up to 0.50 MPa (al)
1.5k ≤ T≤ 800k
Heated gas line available for methane and CO_2

Air sensitive closure with vanadium sample can

P_{max} = 2.5 GPa
1.5K ≤ T ≤ 300K
Sample Size:
10 mm x 6 mm Ø

(a)

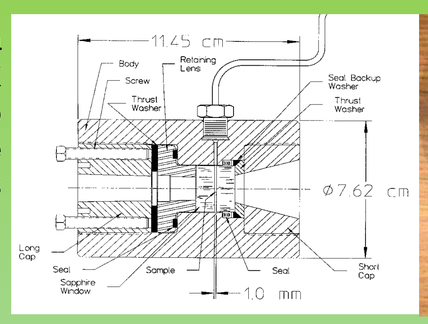


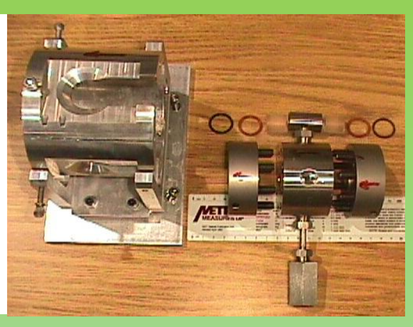
McWhan Clamp Cell schematics and as seen mounted on SD-55 (below)

The sample is axially pressurized between two opposing cylindrical Tungsten Carbide pistons. Hydrostatic uniformity is ensured by immersing the sample in a pressure transmitting media such as Fluorinert (C_8F_{18}), or a 4:1 mixture of deuterated methanol and ethanol
Pressure is monitored through the change in lattice parameters of NaCl

SANS Hydraulic Pressure Vessel

P_{max} = 300 MPa
258K ≤ T ≤ 440K
S.S. body with two containment sapphire windows





(f)

This vessel can be used to pressurize polymer melt mixtures in a wafer form (blends and copolymers confined by an encapsulated o-ring) or soft macromolecular fluids (solutions, micellar systems).
Also used to pressurize flowing liquids though the use of a separator (high pressure tubing containing a piston between the pressurizing fluid and the sample).

Partial list of Citations:

a) T. Hong, et al. "Neutron scattering study of a quasi-2D spin-1/2 dimer system Piperazinium Hexachlorodicuprate under hydrostatic pressure." IN PRESS.
b) C. Tsao, et al. "Neutron Scattering Methodology for Absolute Measurement of Room-Temperature Hydrogen Storage Capacity and Evidence for Spillover Effect in a Pt-Doped Activated Carbon." *J. Phys. Chem. Lett. 2010, 1, 1569–1573.*
c) N. P. Butch, et al. "Antiferromagnetic critical pressure in URu2Si2 under hydrostatic conditions." *Phys. Rev. B* ***82****, 060408 R 2010.*
d) C.M. Brown, et al. "Hydrogen adsorption in HKUST-1: a combined inelastic neutron scattering and first-principles study", Nanotechnology 20, 204025 (2009).
e) A. Kreyssig, et al. "Pressure-induced volume-collapsed tetragonal phase of CaFe2As2 as seen via neutron scattering." *Physical Review B* ***78****, 184517* (2008)
f) A.J. Patel, et al. "Observing Nucleation Close to the Binodal by Perturbing Metastable Polymer Blends." *Macromol.* **40**(5), 1675 (2007).