NMI3 Sample Environment JRA

High Pressure task: Why and what?

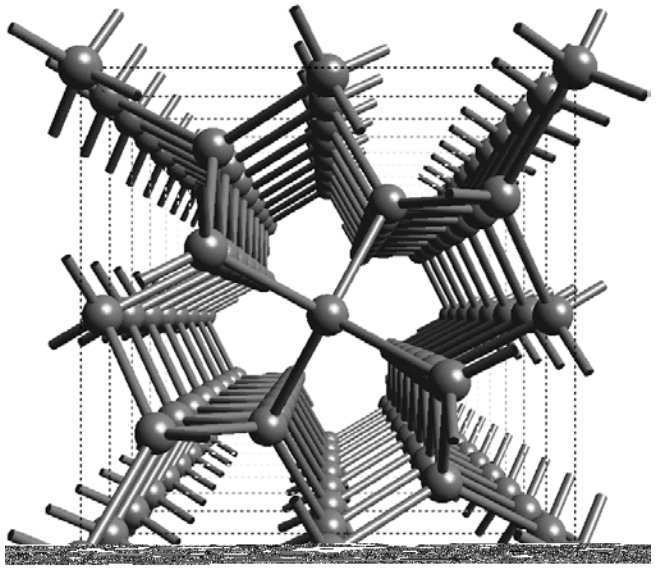
08.10.2009

Why?

- Neutron scattering studies at high pressure quite often require fairly large sample volumes.
- In this case the high pressure technique based on a gas medium compression proved to be very effective.
- The pressure medium is contained in a vessel whose wall thickness is a function of both the mechanical strength of the material and the internal dimensions (size of a sample).
- The vessel wall material should have high mechanical strength as well as acceptable neutron absorption and scattering properties.

Currently this technique covers the pressure range up to ***~ 0.7GPa (7 kbar).***

Why?



The oxygen framework of the twelfth phase of crystalline ice structure viewed down the *c*-axis.

The ***high pressure gas vessels*** are intensively used in neutron scattering experiments in a number of scientific areas (few examples):

- ***Clathrate hydrates***
  Phys. Rev. Lett. **93,** 125503 (2004)
- ***Large isotropic negative thermal expansion***
  Nature **396**, 147 (1998)
  Phys. Rev. Lett. **86**, 4692 (2001)
- ***High-pressure water ices***
  Nature **391,** 268 (1998)
  Phys. Rev. Lett. **93,** 225901 (2004)
- ***Iron arsenides superconductors at high pressure***
  Phys. Rev. B **79**, 024513 (2009)
- ***Metal – insulator transition in perovskites***
  Phys. Rev. B **52**, 9248 (1995)
  Phys Rev B **56,** 8265 (1997)

What?

Inert Gas Cells

Tasks:

1. *High pressure gas vessel technology report*
2. ***13 - 15 kbar*** *'oil' intensifier for hydraulic testing*
3. ***10 kbar*** *automated gas handling system for inert gases*
4. *Design and produce cells and test seal systems up to* ***8 kbar*** *(LT – 300 K)*
5. *Design and prototype* ***10 kbar*** *cells for 300 K*

What?

Hydrogen Cells

Tasks:

1. ***Report*** *on material research (H_2 compatibility and neutron transmission properties)*
2. *Sourcing and assembly of* ***8 - 10 kbar*** *H_2 intensifier and gas handling system*
3. *Produce and test cell for* ***4 kbar*** *and up to* ***700 K***
4. *Produce and test cell for* ***6 kbar*** *and up to* ***300 K***
5. *Design and prototype* ***8 kbar*** *cells for* ***LT – 300 K***

High pressure task - ISIS

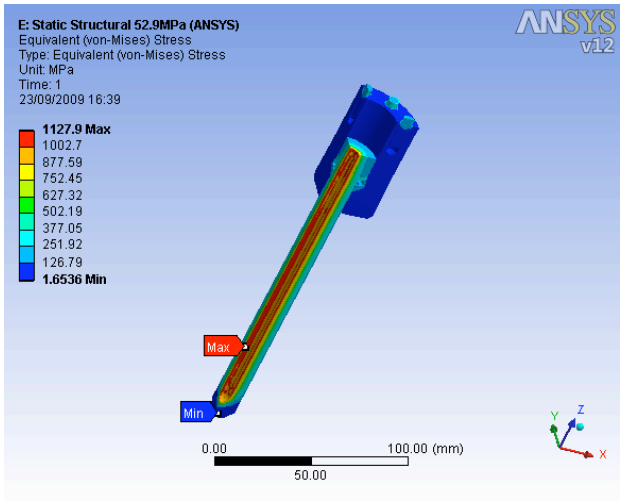
Inert gas cells:

- Report on current technology: draft complete.
- 10 kbar intensifier: specifications complete; intensifier now in manufacture.
- Hydraulic intensifier: 13-15 kbar upgrade work scheduled.

Hydrogen cells:

- Material research and report: collaborative project with Imperial College underway.
- 10 kbar H_2 intensifier: specifications complete and in tender process.
- 4 kbar cell: design stage complete.
- HZB 10 kbar system: visited January 09

Hydraulic intensifier



4 kbar cell: FEA