Developments in High Pressure Clamp Cells for Neutron Scattering at the MLZ

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The availability of pressure devices adapted to the experimental demands (intended pressure, probing method, instrumental environment, etc.) is the fundamental requirement for the study of high-pressure effects on any material property. Our work presents the development of high pressure cells for neutron scattering on polycrystalline and single-crystalline samples at low temperatures and with applied magnetic fields.

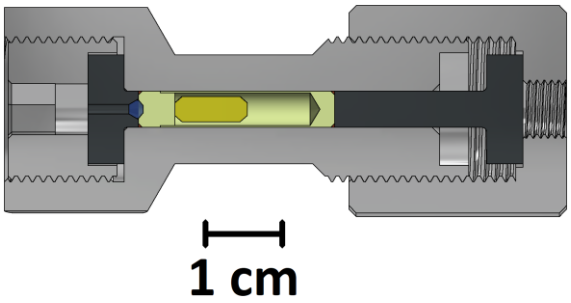

Figure 1: Schematic drawing of the new clamp cell.

In the most common type of device used for high-pressure neutron experiments, the *clamp cell* [1], the pressure is applied *ex situ*, allowing its independent and versatile use in various setups. Our clamp cell design has been specifically developed for neutron scattering experiments at low temperatures in the closed-cycle cryostats on the instruments DNS (diffuse scattering neutron spectrometer), MIRA (cold three axes spectrometer), and POLI (polarized hot neutron diffractometer) at the Heinz Maier-Leibnitz Zentrum (MLZ) in Garching, Germany [2]. The compact monobloc cell is available in two variants, a CuBe alloy and a NiCrAl "Russian Alloy" one, working up to about 1.1 GPa and 1.5 GPa, respectively. Measurements aimed to elucidate magnetic properties are possible due to the low paramagnetic moment of both alloys.

Tests with neutron radiation were performed to calibrate the load/pressure curve of the CuBe cell, to estimate its neutron absorption and background, and to measure magnetic reflections. In addition, the thermal response of the cells in the instrument cryostat was measured and the experimental findings were complemented by simulations.

A second, modified version of the cell with the same mechanical properties (*Fig. 1*) was developed with an optical access path to the inner part of the cell, which additionally enables the use of ruby luminescence to determine the pressure independent from neutrons. The respective load/pressure calibration curves were measured for both cell variants.

Ultimately, these cells are intended as standard cells for high pressure measurements on different instruments at MLZ suitable for all available magnets and cryostats down to 1.5 K.

[1] Klotz S. Techniques in High Pressure Neutron Scattering. CRC Press (2013)
[2] Eich A *et al.* Clamp Cells for High Pressure Neutron Scattering at Low Temperatures and High Magnetic Fields at Heinz Maier-Leibnitz Zentrum (MLZ), High Press. Res., 41[1], 88–96 (2021)

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