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A safe and X-ray transparent aluminium sample cell for high pressure and high temperature nano-diffraction imaging

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The European Synchrotron Radiation Facility beamline ID01 performs Bragg Coherent Diffraction Imaging and X-ray nano-diffraction experiments with in-situ environments. A new sample environment for nanoparticles has been designed and tested. It combines a furnace and a pressurized X-ray transparent chamber, without the use of beryllium for safety reasons. The required 180°C horizontal and 45°C vertical viewing angles necessitate the use of a dome-shaped pressure chamber. Early in the design phase, the thermal effects of the 500°C furnace on the dome's mechanical properties were identified as critical. A Finite Element Analysis (FEA) study was conducted, accounting for heat sources, gas turbulence, and static pressure. Aluminium 6082-T6 was chosen for the pressurized dome, providing a safe and easy-to-procure solution. A dome thickness of 0.5mm provides 80% X-ray transmission at 33keV. The sample, a 200nm-diameter palladium nanoparticle, reaches 340°C in a 50-bar hydrogen atmosphere. Unlike beryllium-based pressure domes, this design uses aluminium, avoiding machining difficulties, procurement issues, and safety hazards.

Footnotes

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