

Using X-rays to improve the durability of Luxfer gas cylinders



Science & Technology
Facilities Council



The Science and Technology Facilities Council (STFC)'s Harwell Imaging Partnership (HIP) has provided Luxfer Gas Cylinders with access to testing facilities at the Diamond Light Source in order to optimise the damage resistance of their product designs.

The challenge

Luxfer Gas Cylinders is the world's largest manufacturer of high-pressure aluminium and carbon fibre composite gas cylinders, supplying high-quality cylinders for a variety of applications, including fire extinguishing, alternative fuel storage and long-term oxygen therapy. As the cylinders must be easily transportable and safe in close proximity to the user, it is essential that they are lightweight and safe for high-pressure operation.

Gas cylinder manufacturing includes a process called autofrettage which improves resistance to fatigue cracking - a crucial performance requirement. The process involves pressurising cylinders and inducing compressive stresses, which greatly improve fatigue life. Similarly, if a gas cylinder is damaged in service, even surviving an initial impact, future fatigue resistance may be compromised due to the loss of compressive stress at the location of damage. To optimise gas cylinder design, it is important to determine stresses induced through both manufacturing and impact damage (e.g. indentation, cracking).

The solution

The Diamond Light Source, funded by STFC and the Wellcome Trust, has X-ray beam line facilities that have made it possible for Luxfer to measure the stress state of a material by measuring the size of the lattice parameter using diffraction.

Separate cylinders were auto-frettaged at different pressures and others were subjected to different kinds of impact damage, to map the residual stress in the damaged regions. The results were used to identify fundamental differences in damage processes and stress states. This enabled the development and validation of finite element analysis models to demonstrate cylinder behaviour and the formulation of novel strategies for targeted design improvements.

The benefits

This work opens up the possibility of developing a quantitative approach to predicting impact damage-related fatigue performance with a reliability that has never been possible before. The project also supports the improvement of the design methods and tools necessary for the development of next-generation gas storage vessels.

Developments in alternative fuel storage will have a positive impact on the environment, while advancements in cylinders for medical or emergency services will support innovative healthcare technologies and improve the safety of emergency first-responders.

Work with us

The Science and Technology Facilities Council (STFC) keeps the UK at the forefront of international science and tackles some of the most significant challenges facing society and industry.

We collaborate with industry, the research community and government to develop business opportunities arising from our world-leading science and technology.

The STFC Harwell Imaging Partnership connects businesses with imaging capabilities and technical expertise from the research community to stimulate innovation and business growth. Capabilities supplied include microscopy, tomography and 'functional imaging' using X-rays, neutrons and lasers.

For more information about how your business could benefit from working with the Harwell Imaging Partnership:

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