Structure Properties of Heat-treated Stone Wool Insulating Material

The Danish Technological Institute (DTI) and DESY have joined forces for on-demand services for the industrial building sector to promote the access of advanced characterization methods to design new materials. In this case a stone wool insulation solution was characterized by using synchrotron X-ray powder diffraction and backscattered electron imaging methods to better contain and prevent building fires for more sustainable and safe cities.

CHALLENGE

ROCKWOOL is a world leading provider of fire resilient stone wool insulation for both residential and non-residential buildings. In areas of urban development, increasingly people are working and living in high-rise buildings. These structures are an effective solution to the challenge of safely housing a growing population. However, the consequences of a fire in a high-rise building can be very serious. People should expect that their homes, workplaces, schools, and hospitals are safe, but building fires do happen. When they do, the safety of the occupants and the first responders depends on how the building performs during the fire. It is seen that building fires today develop five to ten times faster than 50 years ago, due primarily to increased use of plastics and other synthetic materials.
ROCKWOOL stone wool insulation solutions can resist temperatures up to 1,000°C (1,800°F) and work effectively to help contain the fire and prevent its spread. At the same time, stone wool does not contribute to the emission of significant quantities of toxic smoke. Characterizing stone wool insulation by X-ray diffraction can be difficult, due to large quantities of disordered/amorphous phases. In such a case pair distribution function (PDF) data analysis can be used. Here a large range of diffraction angles is needed, which requires high X-rays energies provided by synchrotron radiation.

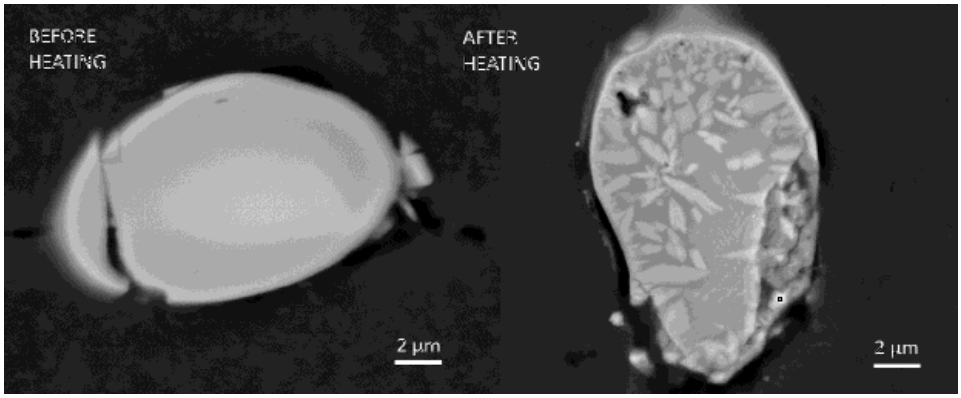

Figure 1: Cross-section of multioxide glass fibre visualized with backscattered electron imaging before and after heat treatment of a stone wool fibre.

ROCKWOOL

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METHOD

Two analytical tools, powder X-ray diffraction (PXRD) at DESY's synchrotron facility PETRA III combined with backscattered electron Imaging measured at DTI were used to characterize structure-properties of multioxide amorphous stone wool fibres upon heat treatment. PXRD measurements were done at PETRA III's beamline P02.1 at 60 keV and were coupled to PDF data analysis.

INSIGHTS AND ANALYSIS

The backscattered electron imaging analytical tool provided insight at microscopic length scales on the structural changes after heat treatment of the stone wool fibres (fig. 1). The fast and reproducible X-ray powder diffraction measurements coupled to a PDF data analysis (fig. 2) allowed the characterization of the crystalline and amorphous phases in the material when affected by extrinsic factors such as high temperature and atmospheric oxygen.

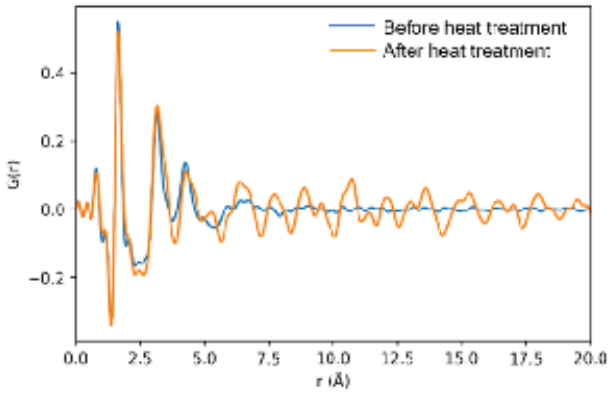

Figure 2: USAXS and WAXS data respectively obtained at PETRA III's P03 beamline.

BENEFITS

This service yielded unique insights on structural changes on the atomic and micrometer length scales upon heat treatment of stone wool fibres for fire-resilient building insulation. and opens the opportunity to use EU synchrotron facilities.

"The DTI service was well planned, on time and the report well detailed. We obtained unique insights for a better understanding of our products behaviors under given conditions and we look forward to future measurements at large scale research infrastructures."

Denis Okhrimenko
Senior R&D Engineer / Group Development, ROCKWOOL

"A great experience. I have never performed measurements at large scale research infrastructures and the DTI service was a valuable support for a fast (!) kick-start and advancement of my PhD project between Rockwool and Aarhus University."

Krestine Rasmussen
Industrial PhD student, Aarhus University

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