Highlight

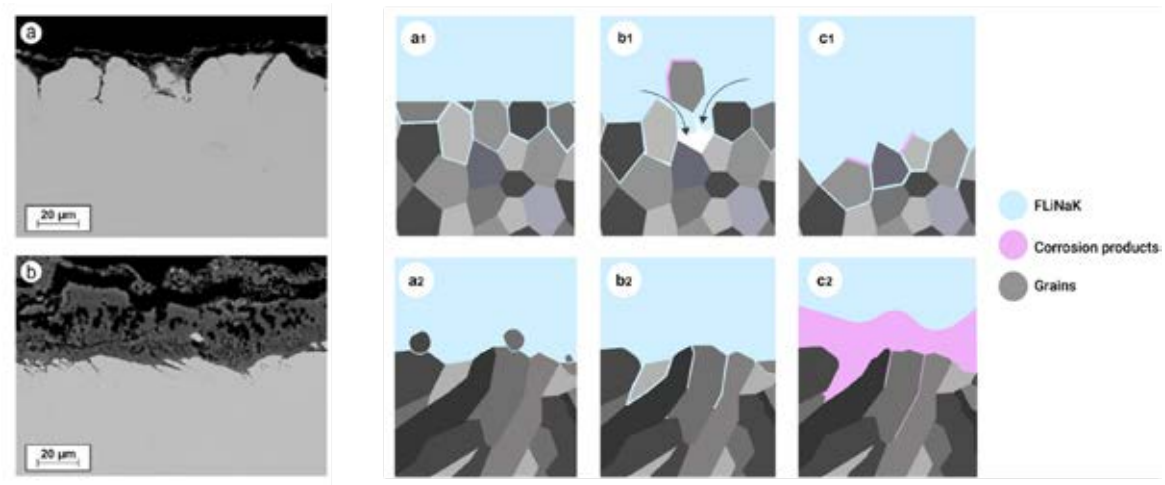
The potential of additive manufactured 316L stainless steel for next generation nuclear reactors

In this work, the corrosion mechanisms of LPBF-processed and hot rolled 316L stainless steel were investigated following exposure to molten FLiNaK salt at 700°C, imitating the conditions of next-generation molten salt reactors. The microstructural differences between the two materials were found to significantly affect their degradation behaviour.

Hot rolled 316L exhibited a continuous grain detachment mechanism, where chromium depletion along grain boundaries led to uniform undercutting and release of surface grains. This produced a steadily retreating corrosion front and resulted in a substantial volume loss, as confirmed by CT-based volumetric reconstructions after 500 hours of exposure to FLiNaK.

In contrast, LPBF 316L displayed discontinuous corrosion progression. Although chromium depletion also occurred, the material developed a stabilized surface layer - likely associated with its fine cellular microstructure and 'interwoven' grain structure - which inhibited full grain detachment. Instead of uniform surface recession, corrosion localized into more narrow penetration paths, ultimately halting further surface degradation.

These findings demonstrate how additive-manufacturing-induced microstructures can alter corrosion behaviour in aggressive environments. They furthermore highlight the importance of accounting for AM-specific degradation mechanisms when evaluating the suitability of LPBF components for demanding technological systems.



SEM BSE images of the cross-sections of a) the wrought sample and b) the LPBF-processed sample exposed to FLiNaK at 700°C for 500 hours. a1-c1) Sketch of corrosion in the wrought sample. a2-c2) Sketch of corrosion in the LPBF sample.

For further reading, please see:

Salbæk M, Jensenius Schollert O, Bredahl Gjelsten X, Juul Jensen D, Barode J, Jellesen M, Hald J, Just Sørensen T (2025), "Comparative Corrosion Performance of additively and conventionally manufactured AISI 316L Stainless Steel in Molten FLiNaK Salt at 700°C", IOP Conference Series: Materials Science and Engineering. 1332, 1, 6 p., 012019.