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Corresponding author: CIUFFINI Andrea Francesco

e-mail of corresponding author: andrea.ciuffini@esrf.fr

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Title

Latest advances in characterization of metallic materials for aerospace industry at European Synchrotron Radiation Facility (ESRF)

Authors

Andrea Francesco CIUFFINI ^{1*}

** Corresponding author*

¹ European Synchrotron Radiation Facility - 71, avenue des Martyrs, CS 40220, 38043 Grenoble Cedex 9, France,
andrea.ciuffini@esrf.fr

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Abstract

In 2021 was completed the upgrade of the European Synchrotron Radiation Facility ESRF – EBS (Extremely Brilliant Source), becoming the first new generation of high-energy synchrotron, increasing brilliance and coherence of X-ray beams by a factor of 100 compared to present-day light sources [1]. The highlights of the research activities in characterization of metallic materials for aerospace industry made in these 2 years will be presented:

- Residual stresses and their relief after heat treatment have been measured in an additive manufactured 316L stainless steel arch structure, using synchrotron x-ray diffraction. The residual stresses generated by the additive manufacturing production process have been measured comparing the synchrotron x-ray diffraction spectra to the stress-free powder spectrum. Further, the stress relief after 2h heat treatment at 700 °C of the additive manufactured arch structure has been evaluated. This experiment is part of EU-funded EASI-STRESS project [2];
- Creep curves at constant 145 MPa σ at 550 °C, interrupted after 10h, 50h, 100h, 150h and 223h performed on a self-healing Fe - 3.8 W - 3.1 Au (wt.%) alloy have been investigated using synchrotron x-ray nano-Computed Tomography (CT). This technique allows the observation of 3D microstructure of the cavities and the precipitates, differentiating Au-rich and W-rich ones. Nano-CT measures also the orientation of cavities and precipitates compared to the stress direction [3];
- Ductile fracture under simple shear stress τ is examined, using synchrotron x-ray in-situ laminography in an aluminum alloy AA2024-T3. This analysis has been used to investigate the evolution of void and particle populations and perform Digital Image Correlation (DIC) to assess the local strain fields. Thus, the damage mechanisms leading to fracture have been highlighted [4].

References

[1] S. Shin - New era of synchrotron radiation: fourth generation storage ring (2021)

[2] <https://www.easi-stress.eu/>

[3] Y. Fu - Self healing of creep-induced damage in Fe-3Au-4W by multiple healing agents studied by synchrotron X-ray nano-tomography (2022)

[4] T. Tancogne-Dejean - Ductile damage of AA2024-T3 under shear loading: Mechanism analysis through in-situ laminography (2021)