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Editorial

Editorial: The June 2022 cover paper

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Introduction

The cover of the June issues of Journal of Materials Science (JMSC) shows a series of electron backscatter diffraction maps of 316L stainless steel processed by laser powder bed fusion additive manufacturing in the as-built state (a) and after recrystallization annealing at 1150 °C for various durations (b-d). This figure will appear as Fig. 7 in an article by Pinto et al. [1] in the upcoming special issue on 'Microstructure design in metal additive manufacturing – physical metallurgy revisited'. This special issue is a collection of 20 review articles, invited viewpoints, and regular articles, most of which by invitation too, submitted by leading and up-and-coming researchers in the field of metal additive manufacturing. These articles were handled by guest editors Prof. Jörg Jinschek (Technical University of Denmark), Prof. Gwénaëlle Proust (The University of Sydney), and myself (Editor, JMSC), with much appreciated coordination by Prof. Grant Norton (Washington State University, Deputy-Editor-in-Chief, JMSC). We selected the cover image for three reasons: (i) the scientific quality of the corresponding manuscript; (ii) its alignment with the topic of area of our special issue; and (iii) based on input from handling editor Jörg Jinschek's family members who are more into the arts than into science and engineering. They thought Fig. 7 was a simple yet attractive series of images, perfect for a cover, and we all agreed to that!

The article itself is a collaboration between researchers from the University of São Paolo in Brazil and the Max Planck Institute für Eisenforschung in Düsseldorf, Germany. It aims to extend our current understanding of the recrystallization behaviour of as-built stainless steel microstructures with typical multi-scale features such as columnar grains, dislocation cells, and finely dispersed nanoscale second-phase particles during post-built annealing, benchmarking it against wrought counterparts. The recrystallization kinetics of the non-conventional as-built laser powder bed fusion microstructure is

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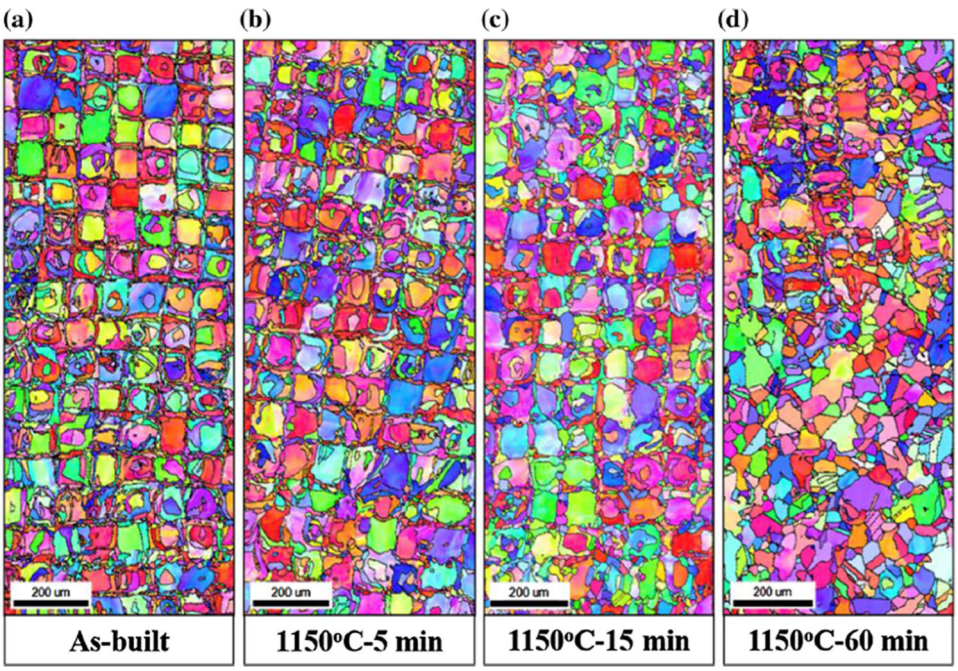
shown to be sluggish, and this is related to the nucleation of recrystallization initiating at non-random sites. These sites are located along the melt pool centres where high stored elastic energy and high misorientations are reported. The local interaction of recrystallization fronts with nanoparticles speeds up their coarsening, causing reductions in Zener–Smith pinning forces.

The authors apply a mosaic scan strategy to achieve these non-conventional starting microstructures, typical for laser powder bed fusion. The ThermoCalc software is used to predict equilibrium phase fractions of second-phase particles as a function of temperature and to provide estimates for bulk diffusion coefficients of the main solute elements in the austenitic matrix. Microstructural characterisation of as-built and recrystallization annealed samples is accomplished using a combination of scanning electron microscopy, energy-dispersive spectroscopy, and electron backscatter diffraction methods. The recrystallization kinetics and particle pinning behaviour are described using the well-known Johnson–Mehl–Avrami–Kolmogorov and Zener–Smith models.

These results will help to understand the most relevant aspects applicable for tuning additive manufacturing microstructures via post-processing heat treatments and enable design of new alloys for laser powder bed fusion and related. This is well-aligned with the first two aims of our special issue, i.e. (i) to carry out multi-scale materials characterization, testing, and modelling to unravel variations in microstructure and properties and (ii) to design microstructures and defects by controlling additive manufacturing process parameters, alloy composition, and post-processing.

Forgetting about the science and engineering behind, the cover image alongside many other figures from the same article (especially Figs. 5, 6, and 9) reminds me of a very colourful version of pointillism meeting Piet Mondrian (Fig. 7 (a), as-built) before transforming into a Gustav Klimt dress pattern (Fig. 7 (b-d), various stages of recrystallization). The latter is of course what must come to mind when a jet-lagged Austrian engineer is staring at electron backscatter diffraction inverse pole figure maps.

I too hope that this little teaser has now piqued your curiosity and that you will check out our special issue in June (or simply visit the 'Metal Additive Manufacturing' article collection on our journal website).



Reference

[1] Pinto FC, Aota LS, Filho IRS, Raabe D, Sandim HRZ (2022) Recrystallization in non-conventional microstructures of 316L stainless steel produced via laser powder-bed fusion: effect of particle coarsening kinetics. J Mater Sci. https://doi.org/10.1007/s10853-021-06859-1