Nuances of the micro-/nano-structure and mechanical properties in an AM stainless steel

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Abstract: Obviating traditional manufacturing and alloy design barriers, additive manufacturing (AM) enables complicated micro-/nano-structures and geometries, unattainable via conventional manufacturing. This advancement has driven the development of advanced materials, e.g., the QT17-4+ stainless steel, tailored specifically for AM. As part of an NSF-BSF-joint effort between Northwestern and Tel Aviv University, we employed selective laser melting and directed energy deposition techniques to process this steel. I outline the alloy design principles guiding the development of this material, elucidating its unique characteristics and advantages, including the formation of structurally and chemically complex metastable phases under AM solidification conditions that enhance its mechanical and physical properties. Leveraging characterization techniques: atom-probe tomography, 4D scanning transmission electron microscopy, electron backscatter diffraction, and synchrotron X-ray diffraction, in combination or correlatively, we study this material at a hierarchy of relevant length scales from many mm to sub-nanometers, to gain a comprehensive understanding of its far-from-equilibrium structure. Furthermore, I address the critical issue of H embrittlement in this AM steel. To understand how its complex atomic-scale structure relates to brittleness when exposed to H, we employ atom-probe tomography to probe the distribution of H atoms within the nanostructure, providing insights into the design of more advanced, hydrogen-resistant materials for AM.

Short Biography: Amir R. Farkoosh is a research associate in the Materials Science and Engineering department at Northwestern University and NUCAPT, working with Prof. David N. Seidman. His current research focuses on designing advanced heat-resistant aluminum alloys and high-strength steels for AM, using a combination of experimental and theoretical methods. Prior to joining Northwestern in 2017, he performed his doctoral research at McGill University in Quebec, Canada, where he studied the physics of creep resistance of high-temperature aluminum alloys. He is the recipient of several awards, including, the Research Excellence Award of McGill University Life Achievement for his Ph.D. work, the Research Excellence Award of McGill University for his postdoctoral research, TMS2017 light metals subject award, McGill Engineering Doctoral Award, and a Fonds de recherche du Québec - Nature et technologies postdoctoral scholarship.