Prof. (Associate) Dr. Vera Popovich
Delft University of Technology
Department of Materials Science and Engineering
The Netherlands
Webpage:
Extreme Materials & Mechanics (X2M) (tudelft.nl)

Lecture Title: Additive Manufacturing of Functionally Graded Materials

Additive manufacturing (AM) is known to allow the production of parts with an extreme degree of complexity, enabling design and functional part optimization. This lecture is focused on development of "programmed", location specific properties through the control of microstructure, composition or porosity in 3D-printed metallic components. It will be shown that AM thermal profiles can be used to manipulate preferred orientation of growing crystals as well as produce grains with different sizes, which affects the Young's modulus, strength and overall mechanical properties. The transitions in microstructure, texture, and properties in functionally graded components can be obtained at relatively small or large length scales, depending upon the functional gradient desired in a particular application. As a proof-of-concept, several graded materials (Inconel 718, Ti6Al4V and NiTi) designed with tailored functional properties will be shown. In particular, graded materials exhibiting core with coarse elongated and outside shell with fine grained microstructure, which allows the best trade-off between creep and fatigue performance, and shows improved thermomechanical fatigue lifetime as compared to conventional material will be presented. The developed graded components represent a composite material, where elongated grains in preferentially textured core enable fatigue cracks deviation into positions perpendicular to the loading direction, hence providing no driving force to cause any crack extension. Application of such materials featuring tailor-made microstructural design and site-specific properties allows for a more efficient use of resources and can be exploited in AM fabrication of complex components requiring challenging functional performance.

Keywords— *Additive manufacturing, functional grading, tailor-made properties, Ni-base and Ti-based alloys, NiTi and shape memory alloys*