

Title: Integrated structural health monitoring by 3D printed metallic structures

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Metal additive manufacturing technologies opened the door to the production of near-net shape products, lightweight structures and allow complex shapes to be manufactured. This innovation in combination with the need for assessment of the structural integrity, also in hard to access areas of engineering structures, has led to the development of an effective Structural Health Monitoring (eSHM) system. The system is based on a network of capillaries integrated in metallic structures to detect and monitor cracks by direct measurement of pressure changes. As these parts, like for example aircraft components in operational conditions, are cyclically loaded, their fatigue life is studied. The specimens with capillary are produced using two AM techniques: the metal-based powder bed fusion, Selective Laser Melting (SLM), and the direct Laser Metal Deposition (LMD) technologies. The existing literature clearly illustrates that the layer-wise manner of building, the rapid solidification and the high cooling rates inherent in AM processes most problably lead to residual stresses, roughness and porosities in the AM components which are negatively influencing the mechanical behaviour and fatigue life. Therefore, four-point bending fatigue tests on AM and conventional specimens were conducted with special attention to crack nucleation, crack propagation, residual stresses and robustness of the eSHM system. The crack detection capability of the novel eSHM concept on a metallic structure has been demonstrated by means of various Non-Destructive Testing (NDT) methods.

Acknowledgement & Biography

Research funded by an SBO Project grant 110070: eSHM with AM of the Agency for Innovation by Science and Technology (IWT) – Dr. Maria Strantza has done the research presented in this work, which has led to her Ph.D. degree in 2016 at VUB. Currently she is at Los Alamos National Laboratory, USA.

Lincy Pyl is professor at the Vrije Universiteit Brussel. Her research expertise is related to structural design&analysis; numerical modelling; metal&composite structures; structural behavior under exceptional loading conditions; mechanical characterization and behaviour of lightweight/3D printed materials under fatigue, under high speed load conditions like blast, impact and crush.

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