Progress Seminar

Seminar Title	: Additive Manufacture of 18Ni(300) Maraging Steel Part: Characterization of Microstructure and Mechanical Properties
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Abstract : It is aimed to study microstructural features and static mechanical properties of Laser Powder Bed Fusion (L-PBF) based additively manufactured Maraging Steel 18Ni(300) specimens. Effects of Direct Metal Laser Sintering (DMLS) parameters (including laser power, scanning speed and layer thickness) on microstructure evolution and mechanical properties (tensile properties, microhardness and dry sliding wear response) are discussed. Microstructural characteristics and microhardness of the post-heat treated specimens are compared to that of the *as built* counterpart. In the present study, the post-heat treatment cycle including Solution Treatment (ST) followed by Ageing Treatment (AT) is attempted. The *as built* specimen is first subjected to ST (at 840 ºC for 2 h) followed by water quenching to the room temperature afterwards, it is subjected to AT (at 492 ºC for 2 h) and finally water-quenched to the room temperature. In comparison with the *as built* microstructure, microstructural alterations after ST, STA ~ ST+AT and Direct Ageing Treatment (DAT) along with microhardness variations are studied. The*as built* specimen exhibits columnar/ dendritic and cellular morphology with epitaxial growth with traces of micro-segregation. The microstructure is dominated by martensite phase with tiny amount of retained austenite. ST and STA (~ ST + AT) treatments cause formation of acicular/ needle-shaped martensite laths due to excessively high cooling rate (water quenching). However, the *as built* microstructural features are found not fully disappeared upon DAT.

It is experienced that DMLS is capable of producing near-fully dense part with average relative density of (98.85 ± 0.54) %. Change in Volumetric Energy Density (VED) with variation in laser power, scan speed and layer thickness causes significant variation in tensile properties. The maximum Ultimate Tensile Strength (UTS) of 1138.5 MPa (with fracture strain &epsilon = 4.3 %) is obtained for the *as built* condition. Lower laser power, higher scan speed setting and wider layer thickness causes porous structure/ void formation and inclusion of partially fused powders within the part which degrades part tensile strength. Microhardness of the *as built* 18Ni(300) varies from 338.6 ± 10.12 $HV_{0.5}$ to 347.8 ± 9.25 $HV_{0.5}$. ST treatment alone causes the minimal microhardness 320.6 ± 12.51 $HV_{0.5}$ whilst DAT causes increased microhardness ~ 468.6 ± 15.63 $HV_{0.5}$. The remarkable improvement in the microhardness value is experienced after STA (ST + AT) treatment (~ 631.3 ± 21.28 $HV_{0.5}$) which is mainly attributed to complete dissolution of segregated elements during ST following which precipitation strengthening during the ageing treatment. It is also noticed that dry sliding wear resistance (at room temperature) of the *as built* 18Ni(300) specimen decreases with increase scan speed as well as layer height and decrease in energy input.