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Mechanical & Materials Engineering
Pierson Graduate Seminar

Improving fatigue performance of additive manufactured metal structures by ultra-stable microstructures

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Currently, additive manufacturing is a popular topic, while laser based additive manufacturing is the most applied technique for metal based additive manufacturing. Laser based additive manufacturing can be used to print complex, hard machining materials and large components. However, the major issue for laser based additive manufacturing is that it introduces thermal tensile stress, which decreases fatigue life of metal components. Fatigue is responsible for 90% of metal failure. In order to improve fatigue life of metal component, a two step manufacturing technology, including laser sintering plus laser shock peening (LSP), was proposed. First, 0D (Nanoparticles), 1D (carbon nanotube) and 2D (graphene or graphene oxide) nanomaterials were integrated into metal matrix by laser sintering. Then laser shock peening was performed to introduce high density of dislocations and novel microstructures. Compressive residual stress and surface work hardening were also introduced by LSP. The interaction between dislocations with nanomaterials helped block dislocation movement, thus stabilizing residual stress and work hardening. The stabilized work hardening and residual stress increased the resistance for crack initiation and crack propagation, so that we can greatly improve fatigue life.

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