Laser shock peening without absorbent coating and its impact on materials properties

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Laser shock peening (LSP) is an innovative metal surface processing technique which is capable of improving the performance of a structure subjected to severe service condition under complex loading e.g. fatigue and stress corrosion cracking by creating near surface compressive residual stress state [1]. Compressive residual stress produced by the LSP process is the result of plastic deformation caused by the propagation of laser induced mechanical shock waves that are created by confinement of plasma generated by high power density laser impinging on the surface of a metal [2]. Despite of having significant amount of research data showing the benefit of LSP in improving the life of components subjected to fatigue, stress corrosion cracking, there is limited understanding in the laser material interaction for such applications and the resulting residual stress magnitude and profile. Currently ablative layer is used in the process which avoids thermal damage of the substrate and also very high pulse energy systems developed for the laser fusion applications are used for the commercial applications making the process difficult and expensive to apply. In the present work, we investigated the effect of various processing parameters on shock wave generation on metallic materials without ablative layer, to identify optimum performance for a laser for this process in various applications. Several experiments were performed to understand the influence of LSP process parameters on residual stress distribution and strain hardening. Influence of confinement layer in shock wave generation was also studied.

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