L.6: Life extension of partly fatigue-damaged spring steel specimens through Laser Shock Peening

Fatigue is responsible for a majority of industrial failures. In a recent study, a significant increase in fatigue life of SAE 9260 spring steel has been obtained through laser shock peening (LSP). As an extension of the previous study, this work evaluates LSP for rejuvenating partly fatigue-damaged spring steel specimens. The approach adopted for the study involved LSP of partly fatigue tested (~50% of mean fatigue life) specimens and comparison of their fatigue lives with untreated ones.

Laser shock peening experiments were performed with an indigenously developed 3J flash lamp pumped Electro-optically Q-switched Nd:YAG laser. Figure L.6.1 shows LSP in progress. Fatigue testing of untreated and LSP-rejuvenated specimens was performed in a three-point bend configuration.

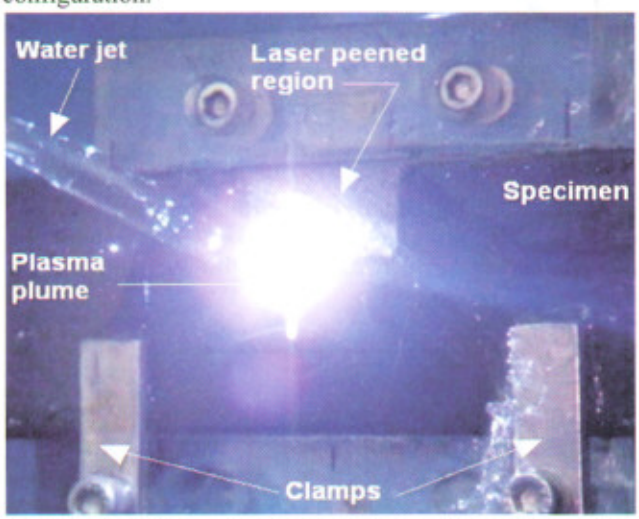

Fig.L.6.1: Picture showing the process of LSP in progress

Laser peening generated about 430 µm deep compressed surface layer with surface stress of about -780 MPa (Fig. L.6.2). Laser peening did not bring about any noticeable change in mean surface roughness (Ra) of ground specimens (Table-1). With respect to untreated surface, laser peened surface exhibited blunting of sharp surface asperities (Fig. L.6.3). Laser peening has also introduced an increase in hardness and yield strength of the treated surface (Table-L.6.1).

Table-L.6.1

	Untreated	Laser peened
Ra (Along & across grinding directions)	0.0438µm/ 0.16 µm	0.04 µm/ 0.156 µm
Hardness	5.23-5.48 GPa	6.45-6.57 GPa
Yield strength	1.95-2.08 GPa	2.34-2.58 GPa

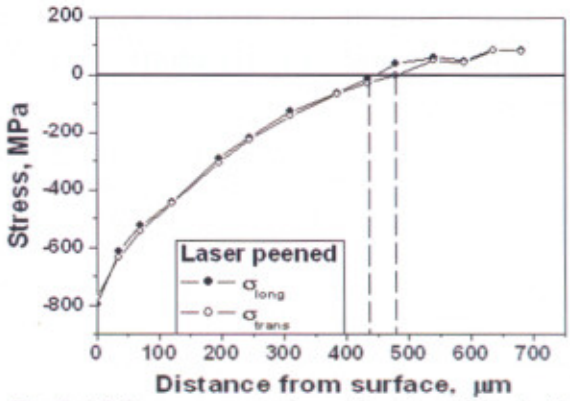

Fig. L.6.2 Stress generated as a function of depth after laser shock peening

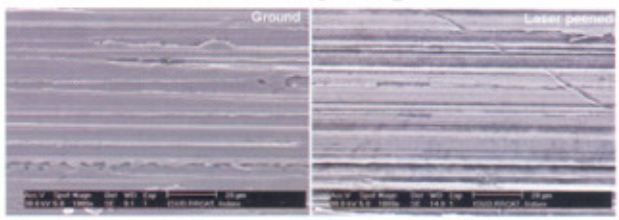

Fig. L.6.3. : SEM image of the unpeened (left) and the laser peened (right) sample

Laser shock peening has been found to be highly effective in extending life of partly fatigue damaged (after enduring ~50 % of mean fatigue life) spring steel specimens. Fatigue tests demonstrated that the life of LSP-rejuvenated specimens was significantly higher than those of untreated specimens. With respect to mean fatigue life of ~2 x 105 cycles (under experimental test conditions) for untreated specimens, LSP-rejuvenated partly fatigue damaged specimens exhibited more than 15 times higher fatigue life (Fig. L.6.4).

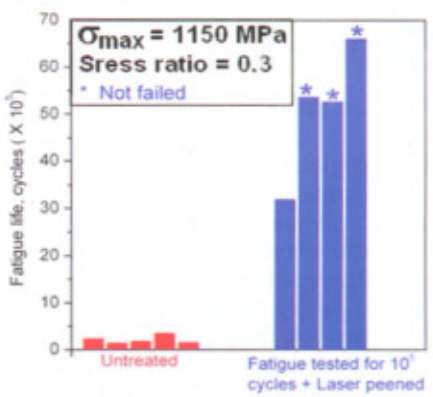

Fig. L.6.4. Bar graph showing the fatigue life of the untreated and shock peened sample

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