

L.6: Laser peening enhances resistance of machined 304L stainless steel (SS) against stress corrosion cracking (SCC)

Stress corrosion cracking in austenitic stainless steels is one of the serious metallurgical problems encountered in Boiling Water Reactors (BWR). It has been recognized that high magnitude of tensile residual stress present on machined surfaces of austenitic SS components makes them susceptible to stress corrosion cracking (SCC).

In a recent collaborative research study between RRCAT and Bhabha Atomic Research Centre (BARC) significant suppression of SCC susceptibility of machined type 304L SS was achieved through laser shock peening. Laser shock peening was performed with an indigenously developed 3 J/7 ns flash lamp pumped electro-optically Q-switched Nd:YAG laser. Laser shock peening generated high magnitude of residual compressive stresses on machined surface of 304L SS specimens, with case depth of about 500 μm (Fig. L.6.1 and Fig. L.6.2).

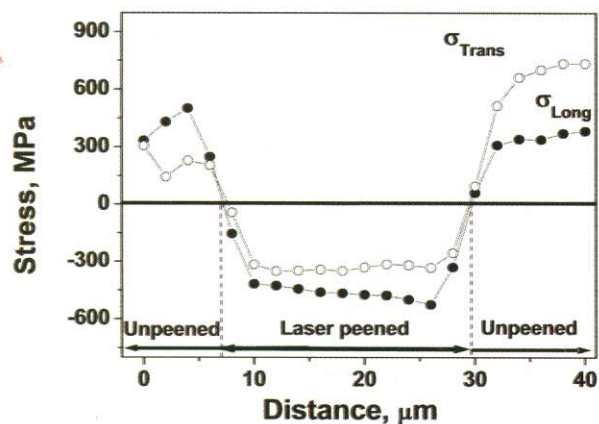


Fig. L.6.1: Surface profiles of residual stress (along two orthogonal directions) across laser peened region.

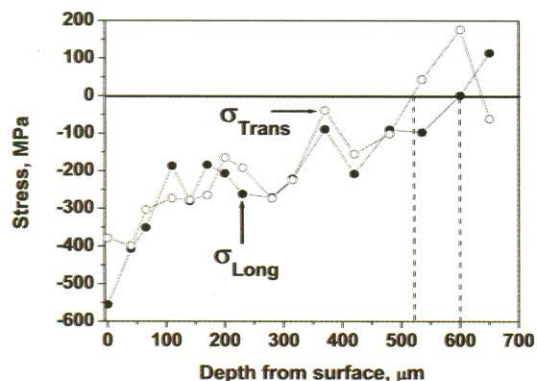


Fig.L.6.2: Depth profiles of residual stress (along two orthogonal directions) in laser peened region.

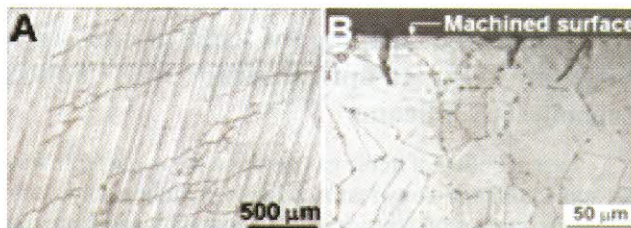


Fig.L.6.3: (A) Stress corrosion cracks on machined surface and (B) cross-sectional view of stress corrosion cracked region in 304L SS specimen.

Laser shock peening introduced a minor increase in mean surface roughness (R_a) of machined surface from 0.52 - 1.2 μm to 0.7 - 1.4 μm . The results of ten hour long accelerated stress corrosion cracking test, performed in boiling solution of $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ as per ASTM G36, demonstrated that with respect to extensive cracking on machined surface, laser shock peened surface remained free of cracks (Fig. L.6.3 & Fig. L.6.4). The study demonstrates effectiveness of laser shock peening, as a life enhancement process, for machined austenitic SS components operating in stress corrosion cracking prone aqueous chloride environment.

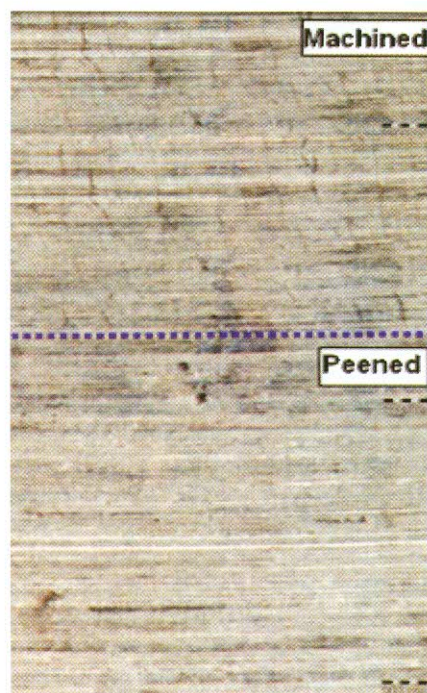


Fig. L.6.4: SCC tested partly laser peened 304L SS specimen. Note sharp transition in cracking across the boundary of machined/peened regions.

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