

L.10 Oblique laser peening enhances stress corrosion cracking resistance

Stress corrosion cracking (SCC) is a major metallurgical problem experienced by austenitic SS (SS) components operating in Boiling Water Reactors and also in chemical industry. Recently, significant suppression of SCC susceptibility of machined 304L SS sheet was demonstrated through laser shock peening (LSP). However, in actual applications, SCC damage is mostly encountered on internal surface of tubular components and life enhancement of such components demand peening on their internal surfaces. In this context, a new approach of oblique laser shock peening (O-LSP) was exploited topeen internal surface of a 304L SS tube (OD = 111 mm; ID = 101 mm). O-LSP experiments were performed with an indigenously developed 2.5 J, 8 ns Nd:YAG laser at 60 angle of incidence (Fig. L.10.1) which yields maximum peening length of ~150 mm.

Machined internal surface of SS tube displayed high magnitude of tensile stress (200-500 MPa) along circumferential (i.e. machining) direction while longitudinal direction carried low magnitude of residual tensile/

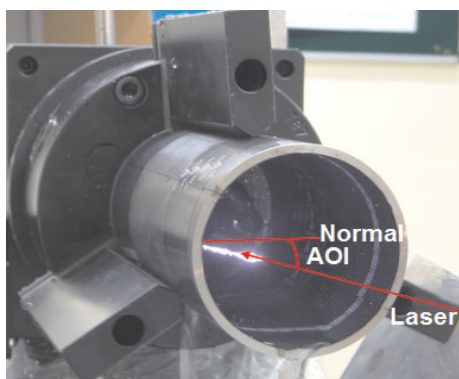


Fig. L.10.1: O-LSP of internal surface of a 304L SS tube at 60 angle of incidence.



Fig. L.10.2: SCC on machined internal surface of SS tube.

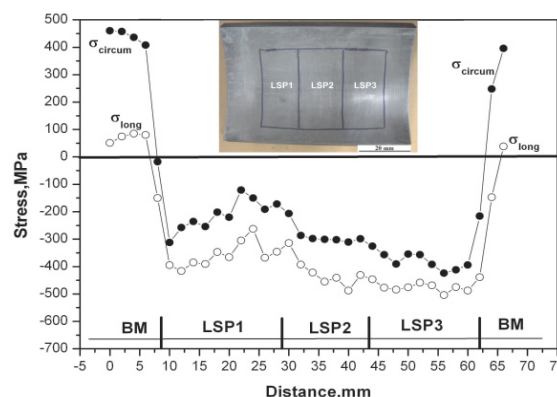


Fig. L.10.3: Surface residual stress profiles across oblique laser peened regions (shown in inset). LSP1, LSP2 and LSP3 refer to single, double and triple peened regions.

compressive stress. Accelerated SCC testing of this tube (as per ASTM G36; test time: 8 hrs), generated extensive cracking on its internal surface (Fig. L.10.2). O-LSP effectively introduced compressive residual stress on machined surface and the magnitude of resultant residual compressive surface stress increased with repetitive O-LSP treatments (Fig. L.10.3). Accelerated SCC testing of oblique laser peened specimens demonstrated significantly reduced SCC susceptibility of oblique laser peened surface. Among the three SCC-tested single laser-peened specimens, two remained crack-free, while third specimen displayed three short cracks near the boundary peened region. On the other hand, double and triple peened specimens remained crack-free. Figure L.10.4 presents suppression of SCC susceptibility in triple peened sample.

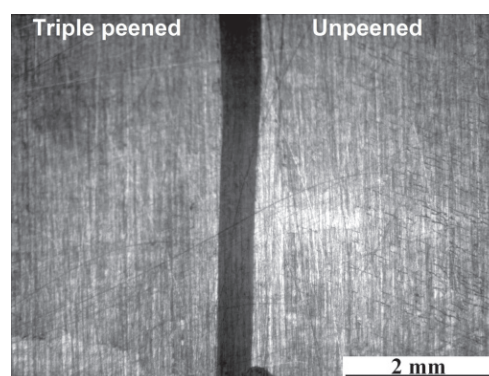


Fig. L.10.4: SCC on unpeened and triple peened surface of SS specimen. Extensive cracking in unpeened region against crack-free triple peened region.

Reported by:
R. Sundar (sundhu@rrcat.gov.in), R.K. Gupta,
and B. Sunil Kumar (BARC)