Contribution ID : **73** Type : **Poster**

Influence of tempering and surface grinding on the residual stress of 415SS laser clad hypereutectoid rail components

Thursday, 12 November 2020 17:24 (1)

A growing reliance on critical transport infrastructure combined with the dependence upon railway for mining and mineral export has heightened operational requirements and lead to premature failure of rail components under severe loading conditions caused by plastic deformation, rolling contact fatigue and accelerated wear rates. Rail replacement is a costly and disruptive undertaking therefore in-situ maintenance is necessary for ongoing repairs to keep these extensive railway networks operational. Traditional maintenance techniques such as arc welding can be damaging to the rail and promote undesirable microstructural changes and softening due to the large thermal input. Laser cladding is an emerging regenerative maintenance strategy that utilises a high energy laser to metallurgically bond a deposition layer that imparts superior mechanical and tribological properties to restore the rail profile. Despite the smaller heat affected zone (HAZ) generated from the reduced thermal input, laser cladding produces a complex residual stress state due to thermal gradients, phase changes and solidification shrinkage. It is the combination of residual stress and cyclic wheel-rail contact stresses that govern the rail fatigue behaviour and susceptibility to wear and defect formation, therefore high internal stresses may increase the likelihood of failure.

415SS is a new martensitic stainless steel alloy developed to recondition hypereutectoid rail substrates and contains beneficial compressive stresses in the untempered cladding deposition, determined using neutron diffraction techniques. For in field applications, laser cladding repairs require further tempering and rail grinding procedures to prepare the surface for wheel contact by achieving the required mechanical properties and reducing surface roughness to minimise friction, wear and noise. Both thermal and machining processes alter the post cladding internal stress state which in turn impacts the fatigue behaviour.

Non-destructive neutron diffraction has been undertaken on the Kowari strain scanner at ANSTO to assess the effect of post cladding tempering and surface grinding on the residual stress of 415SS clad high carbon rail. The triaxial residual stress distribution was measured after 350oC and 540oC tempering processes and surface grinding to remove 0.5 mm and 1.4 mm from the cladding surface. Strain scanning was also performed on a disc with a 0.4μm surface finish. The research outcomes from this investigation will assist in better understanding the effect of post cladding processes on the rail fatigue behaviour as accurate measurement of the internal stress state is a critical aspect in developing a viable laser cladding maintenance strategy. These findings will be used in conjunction with full microstructural and mechanical property evaluation to determine the influence of cladding repairs on rail performance and identify the most desirable parameters for post cladding procedures to optimise the operation lifetime of rail components.

Speakers Gender

Female

Level of Expertise

Student

Do you wish to take part in the poster slam

No

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Session Classification : Poster Session

Track Classification : Manufacturing & Engineering