Investigating the Spall and Quasi-Static Tensile Responses of Commercial Lean Duplex Stainless Steel Alloys

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Abstract

Lean duplex stainless steel alloys 2404 (LDX2404) and 2101 (LDX2101) are the most recent types of commercial duplex stainless steel alloys [1, 2]. These alloys were introduced by Outokumpu to have high corrosion resistance and mechanical properties at relatively lower costs compared with conventional stainless steel alloys such as 2205 and 316[1, 3]. These alloys have almost the same volume fractions of austenite phase and ferrite phase. The tensile response of these alloys was studied at a strain rate of 10^{-3} s^{-1} using a universal testing machine. The dynamic tensile response (spall response) of both alloys was studied via the recovered plate impact experiment using a 70 mm bore single-stage gas gun. In the plate impact experiments, momentum trap rings were used to remove/mitigate the effects of radial release waves and ensure that samples tested under uniaxial strain wave [4]. The microstructural examinations were performed on the as-received and recovered samples using optical microscopy, scanning electron microscopy and Electron Backscatter Diffraction (EBSD).

Results indicate that LDX2404 has higher yield and ultimate tensile stresses at the quasi-static condition compared against LDX2101. Both alloys experienced spall damage at impact velocities around 250 m/s. The spall strength measured from free surface velocity profiles shows that LDX2404 has a higher spall strength than LDX2101. This enhancement in the mechanical response of LDX2404 could be accounted to a smaller grain size and high content of alloying elements compared with LDX2101. The spall damages were parallel to the phase boundaries and normal to the impact direction for samples shocked in parallel to the normal direction as shown in Fig. (1) and Fig.(2). Austenite phase works as barriers to the growth of the spall voids in both materials as shown in Fig.(2), and most of the damage was accommodated by the ferrite phase.

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Fig.(1) Processed optical image of the recovered sample of LDX2101 form plate impact experiment at an impact velocity of 264 m/s.

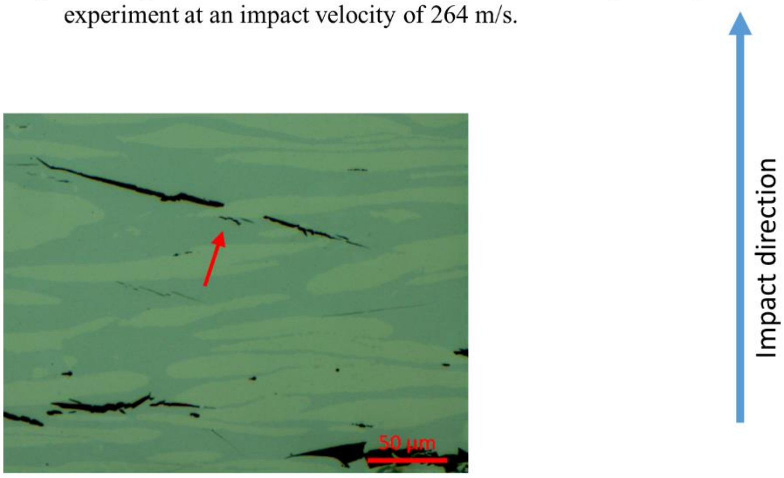

Fig.(2) optical image of the recovered sample of LDX2101, red arrow shows the propagation of the crack in the ferrite phase (greenish coulure) and around the austenite phase (yellowish colour).

References

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