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Influence of preheat treatment on intergranular corrosion of duplex stainless steel 2205 in short time ageing

Mojtaba Dehghanpoor[1]*, Masoumeh Naghizadeh[1], Mohammad Hadi Moayed[2]
[1]Postgraduate student, Metallurgical and Materials Engineering Department, Ferdowsi University of Mashhad, Mashhad91775-11, Iran
*Email: mojtaba.de65@gmail.com
[2]Associate Professor, Metallurgical and Materials Engineering Department,Ferdowsi University of Mashhad, Mashhad, Iran
mhmoayed@um.ac.ir

It is well recognized that inappropriate heat treatment deteriorates the intergranular corrosion resistance of duplex stainless steels due to precipitation of deleterious phases such as chromium nitride, chi phase and sigma phase(1) which leads to chromium depletion at grain boundaries(2). It is worth to say that the state of secondary phases depends on previous heat treatment(2). The objective of this work is to study the influence of preliminary solution annealing heat treatment that results in different fraction of ferrite and austenite, on sensitization of 2205 duplex stainless steel at short time ageing. Samples were solution annealed at 1050°C, 1150°C, 1250°C, for 45 min, followed by water quenching. Subsequently, alloy in each annealing condition were submitted to reheating temperature of 850°C for 10 min and 30 min prior to water quenching. It was previously stated that the fastest precipitation rate for sigma phase is at 850°C (1). Degree of sensitization (DOS) was investigated by Double-loop electrochemical potentiokinetic reactivation (DL-EPR) method, using a modified solution for DSS 2205 steel consisted of 0.25 M HCl + 0.002M Na_2S2O_4.

Fig. 1 shows current vs. time curves obtained from DL-EPR test for specimens aged at 850◦C at various pre solution annealing temperatures. A multiple current maxima was observed in both anodic and reverse scan indicating different dissolution behavior of two phases due to duplex nature(5, 6)

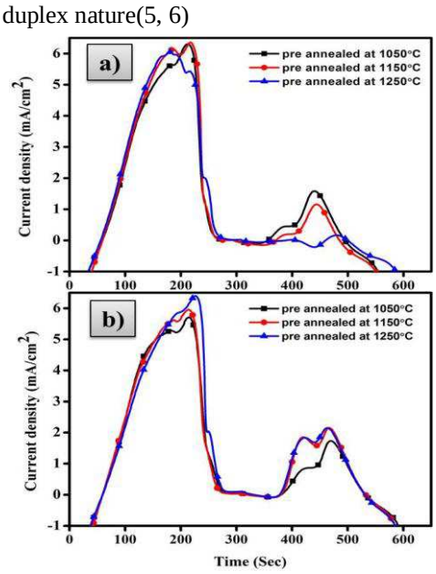

Figure 1. Current density- time curves of DSS 2205 in various pre solution annealing treatments after exposure to 850°C for a) 10 min and b) 30 min, obtained from DL-EPR test.

Generated charge (Q) was selected as the criterion to measure DOS. Fig 2 shows the Q_r/Q_a as degree of sensitization where Q_r and Q_a are generated charge in reverse and anodic scan respectively(3,4). Illustrated DOS% shows no sensitization for annealed (zero aging time) specimens. Ageing for 10 min shows that DOS% has been increase for all specimens, although the amount of DOS decreases by increasing in pre annealing temperature. At longer ageing treatment, this behavior is changed and DOS% for specimen pre annealed at 1050°C is the lowest among the specimens. However the DOS% for ageing at 30 min for the specimens pre-annealed at 1150°C and 1250°C are almost the same, but the rate of increase in deterioration for the sample of pre-annealed at 1250°C is higher than 1150°C.

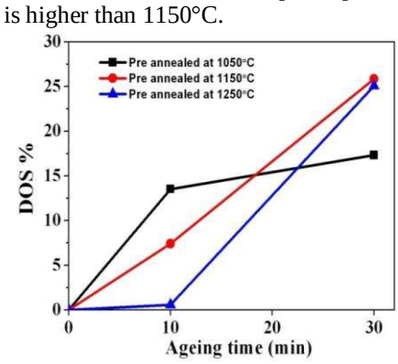

Figure 2. DOS% vs. exposure time, obtained from DL-EPR test for2205duplex stainless steel, pre annealed at different temperatures.

Optical microscopy of aged samples revealed that annealing at higher temperatures causes a retardation of secondary phase precipitation (fig. 3). It could be seen that as exposure time continues, no significant change in amount of secondary phases in sample that initially annealed at 1050°C is appeared, while higher rate of secondary phase formation is evident for specimens that was pre annealed at 1150°C and 1250°C. It seems that precipitated secondary phase in specimen pre annealed at 1250°C are much smaller in size and more distributed at grain boundaries compared to the one that pre annealed at 1150°C.

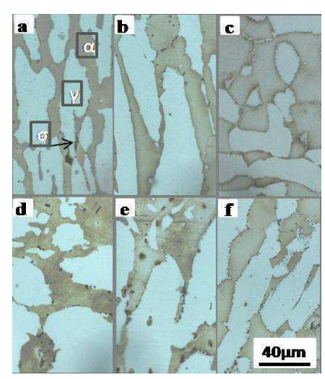

Figure 3. LOM micrographs of DSS 2205 pre annealed at a) 1050°C b) 1150°C c) 1250°C after 10 min and d) 1050°C e) 1150°C f) 1250°C after 30 min

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