A justification on critical pitting temperature (CPT) proposed by Salinas-Bravo and Newman / Microstructural changes of 2205 Duplex stainless steel (DSS 2205) study

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Critical pitting temperature (CPT) has been defined by Salinas-Bravo and Newman as a temperature which $i_{lim}=i_{crit}$ where i_{lim} is the limiting current density and i_{crit} is the critical current density necessary for passivity(1).

DSS 2205 duplex stainless steel is typically solution annealed at 1050°C that leads to approximately equal volume fraction of ferrite and austenite phases(2). Deterioration of CPT due to solution annealing at 1250°C as a consequence of chromium nitrides (Cr_2N) precipitation was presented in detail elsewhere and the lower value of diffusion limiting current density for sample solution annealed at 1250°C was purposed as a possible reason for lowering alloy CPT(3).

The aim of this work is to investigate the alloy microstructural changes on CPT by evaluating the anodic critical current density in simulated pit environment.

Potentiodynamic polarization tests were performed using 200µm electrodes solution annealed at 1050°C and 1250°C. A 5M HCl solution was selected to simulate the pit solution(4).

Typical potentiodynamic polarization curves of specimens at various temperatures are illustrated in fig. 1 and fig. 2. Surface passivity was evident at temperatures below 45°C while diffusion controlled dissolution was shown as a result of precipitation of salt film at higher temperatures.

Each test was repeated at least three times and the average values of critical current densities were plotted vs. temperature (fig. 3). The value of i_{crit} increases with temperature linearly. This trend is changed at temperature around 50°C, as a result of salt precipitation. Once the salt precipitation occurs, the maximum current density could not exceed from diffusion limiting current density. So that the linear trend of i_{crit} vs. time was extrapolated to higher temperatures.

For the specimen solution annealed at 1250°C, the results show an increase in the slope of i_{crit} vs. temperature curve in comparison with one annealed at 1050°C. This increase may be related to chromium depletion as a consequence of chromium nitrite (Cr_2N). Our results support the mechanism proposed by Salinas-Bravo and Newman for CPT. So it can be concluded that deterioration in critical pitting temperature of 2205 DSS solution annealed at 1250°C is attributed not only to decrease in i_{lim}, but also to an increase in i_{crit}.

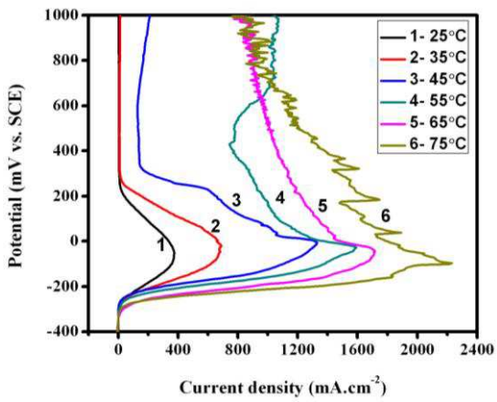

Figure 1. Typical potentiodynamic polarization curves of DSS 2205 alloy solution annealed at 1050°C in 5M HCl solution at various temperatures. (Scan rate is 5 mV/Sec)

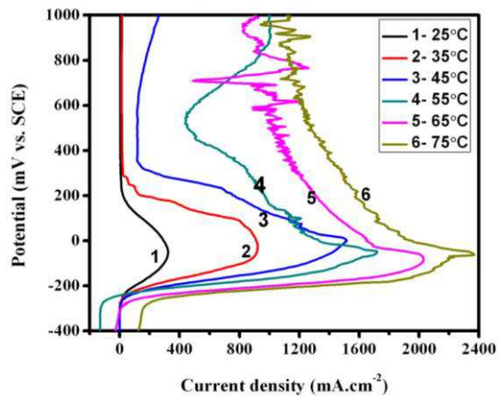

Figure 2. Typical potentiodynamic polarization curves of DSS 2205 alloy solution annealed at 1250°C in 5M HCl solution at various temperatures. (Scan rate is 5 mV/Sec)

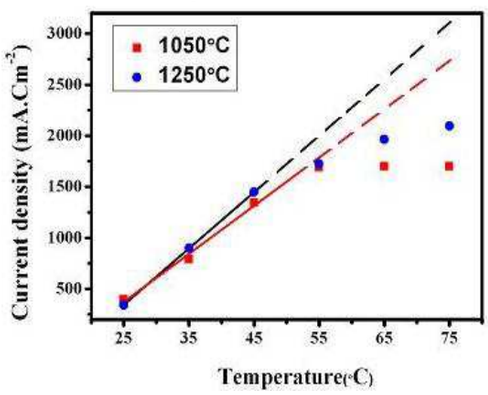

Figure 3. Critical current density vs. temperature obtained from potentiodynamic polarization curves of DSS 2205 alloy at different solution annealing condition.

References:
1. V. M. Salinas-Bravo and R. C. Newman, Corrosion Science, **36**, 67 (1994).
2. F. Eghbali, M. H. Moayed, A. Davoodi and N. Ebrahimi, Corrosion Science, **53**, 513 (2011).
3. M. Naghizadeh and M. H. Moayed, in 23rd ECS Meeting, Toronto, Ontario, Canada (2013).
4. R. C. Newman and T. Shahrabi, Corrosion Science, **27**, 827 (1987).