Effect of ECAP on the pitting corrosion of 304 stainless steel

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Stainless steel (SS) is regarded as one of the most widely used metallic materials in industry due to its high corrosion resistance. However, the pitting corrosion in chloride-containing media affects greatly the practical application of SS [1,2], especially for the fine-grained SS by severe plastic deformation (SPD), e.g. equal channel angular pressing (ECAP) [3].

In order to explore the effect of ECAP on the pitting corrosion of SS, as-received (0-pass), 1-pass, 4-pass and 8-pass specimen were used. The influence of ECAP on the pitting corrosion of the samples is investigated with respect to microstructure refinement by measuring pitting initiation frequency and potentiostatically growing pit test in the electrolyte of 0.1 M NaCl.

The results of tests above show that a maximum pitting initiation frequency at Open Circuit Potential is confirmed for 4-pass ECAP (see Table1) which mainly correlates to the relatively high dislocation density (see Fig.1), and a direct influence of dislocation piling-up and an indirect role of deformation-induced martensite as a piling-up stabilizer on pitting initiation frequency are postulated to explain the result. In the potentiostatic regime, 4-pass ECAP is shown to lower the repassivation ability and increase the number of stable pits (see Fig.2 and Fig.3). Further ECAP pass (8 passes) enhanced the pitting resistance of SS not only for decreasing dislocation density (see Fig.1) but also for grain refinement (nanocrystalline structure of 8-pass sample had been confirmed in the previous researching result [4]), confirming the advantageous role of microstructure change during ECAP in pitting corrosion of stainless steels. It is also not difficult to find that the pitting corrosion resistance of all ECAPed samples is not improved compared with 0-pass one.

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Table 1 Number of metastable pits as a function of ECAP pass

Grade	Solution	0-pass	1-pass	4-pass	8-pass
304	0.1M NaCl	200	380	450	230

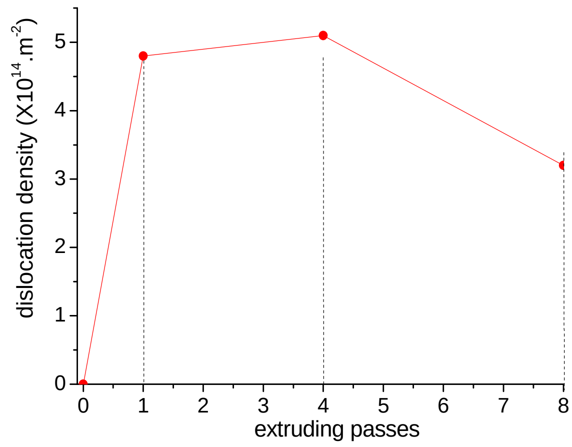

Fig.1 Dislocation density change as a function of ECAP pass

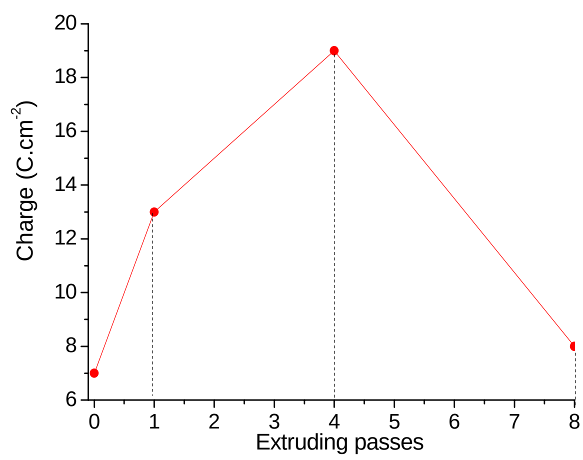

Fig.2 Total electric charge from pits growth period under potentiostatic regime on 304 as function of ECAP pass

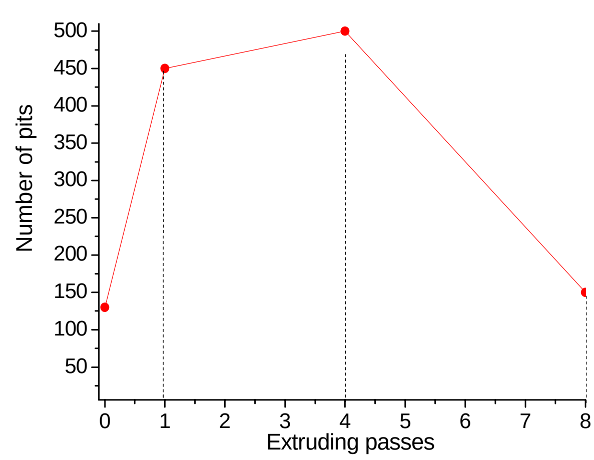

Fig.3 Number of macroscopic pits measured by potentiostatic test on 304 SS as a function ECAP pass