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# ORIENTATION DEPENDENCE OF STRESS CORROSION CRACK IN COLD ROLLED ALPHA BRASS (*)

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The phenomenon of stress corrosion cracking has been investigated in its various aspects starting from as early as 1914. Upto date the phenomenon has been investigated at different conditions of temperature, stress, strain, work hardening, heat treatment and grain size in different media. The results indicate that the suceptibility of brass is extreme in presence of ammonia. Suceptibility decreases with grain refinement and alloying of elements such as Si, Ba, Mg, As, P. Various hypotheses have been proposed to explain the phenomenon. But the knowledge is not yet complete to formulate a general theory to explain the phenomenology of stress corrosion failure of alloys. There is general agreement that failure is due to combined effects of corrosion and stress. The confusion lie in share of the responsibilities of the two agents, corrosion and stress, in the initiation and propagation of the crack.

There is a general agreement that crack is formed as a result of electrochemical nature of corrosion. Difference of potential exists between discrete areas of the structure of the metal and the anodic areas dissolve into the electrolyte forming pits. This produces a stress concentration around the pit due to stress applied and crack is initiated. The anodic locality has been proposed to be caused due to many different reasons. Stress is said also to assist in an indirect manner by rupturing apart the film of corrosion product initially formed or by providing energy for movement of dislocations or by precipitation of solutes and phases.

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Diverse explanations have been forwarded about propagation of crack resulting in failure. Some investigators propose that cracks propagate as alternating steps of slow anodic attack resulting in extension of crack in small magnitude and of sudden mechanical fracture resulting in a greater yet microscopic extension; others explain that the brittle fracture is triggered by the wedging action of the build up of corrosion products at cathodic areas near the advancing edge of the crack. Some others claim, continuous accelerated corrosion was the principal mechanism of crack propagation. Another school of thoughts propose, fine cracks appear along the traces of 111 and {110}, which later arrange themselves to the direction of stress. Failure occur when these cracks connect. Recently parallel arrangement of pits have been observed by electron microscope which has led to suggest that the pits may be forming on the traces of {111} planes.

## EXPERIMENTAL PROCEDURE AND RESULTS

An apparatus for test at constant load, was fabricated for testing the susceptibility of the alloys to stress corrosion failure while in atmosphere of the corrosive media. An atmosphere of 68.9% air, 27.8% ammonia and 3.3% moisture was used.

In the laboratory, alpha brass was prepared and rolled to 0.081 cm thick strips after varying degrees of cold work. Test specimens were 0.476 cm wide, 11.43 cm long and 2.5 cm long between necks. They were stressed under a load of 6.7 $Kg/mm^2$. The results of the variation of cold work with time of failure is presented in the Table 1. The results show that at initial stages of cold work, the time of failure decreases in comparison to the annealed specimen and later increases at higher amount of cold work.

Table - 1

| % Cold reduction | Time to failure(min) Average 70-30 Brass |
|---|---|
| Annealed | 193 |
| 10 - 15 | 172 |
| 20 | 155 |
| 30 | 256 |
| 50 | 290 |
| 70 - 80 | 439 |

The plame of fracture in specimens cold rolled below 30% was more or less normal to the direction of stress while fracture planes in sample cold rolled above 30% bore a definite inclination to the direction of stress. The electropolished surface of such a specimen revealed pits along the traces of the {111} planes on the rolling plane (110).

DISCUSSION

The shorter time of failure as indicated in Table 1 at the initial stages of cold work may be explained to be due to the generation of dislocations on the slip plane and their subsequent piling up at the grain boundaries catalysing the corrosion of the grain boundary. Experimental evidence has been obtained recently by other investigator about the formation of pits at grain boundaries in specimens cold worked upto 20% or lower.

The angle of inclination of plane of fracture appears to be due to the nature of preferred orientation caused by more than 50% cold reduction. As orientation approaches the ideal state (110) $[1\bar{1}2]$ for a cold rolled brass; Octahedral planes are oriented at an angle of $35^o$ and $90^o$ to the (110) plane. The line of intersection of the (111) and $(\bar{1}\bar{1}1)$ planes on the (110) plane which are inclined at $35^o$ to the (110) plane makes an angle of $54.7^o$ to the direction of stress $[\bar{1}12]$. The pits mentioned above were observed along these lines. The calculation of resolved shear stress on the slip planes shows a maxima on the (111) and $(\bar{1}\bar{1}1)$ planes confirming the formation of pits on the traces of above planes.

CONCLUSION

The appearance of pits along the traces of {111} planes and their propagation suggests their coincidence with the dislocation sites. The experiment provides a verification of the recent hypotheses. The fracture plane indicates that the octahedral planes when inclined at $35^o$ to the rolling plane and on which resolved shear stress is maximum become the weakest plane for seperation. This signifies that, after formation of pit dislocations moves under the stress to stress field regions enlarging the diameter of the tunnel and weakening the cohesion of the active slip planes to a minima.

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