The Crevice corrosion is a localized form of attack that occurs at shielded areas on the metal surfaces exposed to certain specific corrosive environments. This type of corrosion occurs very frequently in engineering structures particularly with threaded or rivetted joints, gasket fittings, welded lap joints and coiled or stacked sheets. The crevice corrosion susceptibility of a metal is dependent on the geometry of the crevice, chemical environment and the metallurgical state of the material. The aim of the present investigation is to study the influence of the microstructure on the crevice corrosion behaviour of austenitic stainless steels in aqueous medium containing chloride ions. Austenitic stainless steels have excellent uniform corrosion resistance but are highly susceptible to localized corrosion like pitting, crevice corrosion and stress corrosion cracking. The steels chosen are AISI type 304 (18 Cr, 10 Ni), 316 (17 Cr, 12 Ni, 2Mo), 310 (25 Cr, 20 Ni) and these are selected for the following reasons. (i) For a given chromium content, the increase in nickel in austenitic stainless steels increases the stacking fault energy (SFE) which will have considerable influence on the microstructure of the material. (ii) These steels find important applications in nuclear and chemical industries, steam generator plants and biomaterials. 

- (iii)
As there is no universally accepted or standard test method for the study of crevice corrosion susceptibility as a function of metallurgical variables, a crevice assembly has been designed and fabricated for the purpose. The crevice corrosion resistance has been measured using a potentiodynamic method in terms of a critical crevice potential, \( E_{cc} \). The higher is the susceptibility of the material, the more active is the \( E_{cc} \) value. The metallurgical factors considered in this study are as follows: crystallographic texture, grain size, carbide precipitation (sensitization), dislocation arrangements and non-metallic inclusions. The texture and the dislocation arrangements depend on SFE of the stainless steel and can also be varied by cold work while the grain size and carbide precipitation leading to sensitization can be controlled by heat treatment. The effect of non-metallic inclusions has been studied using materials of different cleanliness.

The potentiodynamic as well as galvanostatic studies were made using the standardised crevice assembly and in a neutral 0.5 N NaCl solution at ambient temperature. In the potentiodynamic test the \( E_{cc} \) value was independent of scan rate in the range 5 - 100 mV/min and a scan rate of 10 mV/min was chosen for the present studies.
The crevice corrosion potential was measured on solution annealed specimens as well as on specimens cold rolled to different thickness strains in the range 5 - 20%. The measurements were made on the three perpendicular cross sections with a view to evaluate the effect of texture. The grain size variations were achieved by thermo-mechanical treatments and the specimens with different degrees of sensitization were prepared by soaking at 1023K for varying times between 20 min to 24 h followed by air-cooling to ambient temperature.

The texture in the specimens was measured using X-ray techniques. The integrated line intensities as well as pole figures were recorded on the specimen surface. The microstructure was examined using optical, transmission electron and scanning electron microscopic techniques.

The crevice corrosion resistance of 316 stainless steel was better than 304 and 310 when tested on the rolling surface and this is attributed to the beneficial effect of molybdenum in 316. Also, 310 stainless steel showed lower resistance to crevice corrosion than 304. The inclusion content in the steels studied (cleaner grades) did not have any significant effect on the crevice corrosion susceptibility. The $E_{cc}$ measured on the rolling surface of the solution annealed 316 and 310 steel was more noble than
that obtained on the two perpendicular surfaces (transverse and cross-transverse). In solution treated 304, however, all the three sections of the specimen had similar $E_{cc}$ values. The crevice corrosion resistance of all the three stainless steels decreases with cold work up to about 5 - 15% and a further increase has negligible effect. In cold rolled condition, all the three stainless steels showed more noble $E_{cc}$ values on the rolling surface than on the other two sections. The above results are interpreted in terms of the textures developed in the three different steels. In solution annealed condition, 316 and 310 steels have shown $\{112\} <111>$ type texture while 304 showed a less ideal texture $\{112\} <231>$. In the cold worked state (20%), the texture in 304 and 310 has been $\{011\} <211>$ and that in 316 has been $\{112\} <111>$. The difference in crevice corrosion behaviour is attributed essentially to the variations in the crystallographic nature of the exposed surface. When the materials are in cold worked condition, however, there could be a contribution from the changes in the grain size from one surface to a perpendicular surface. The results indicate that the resistance to crevice corrosion of a given material improves when a less close-packed crystallographic plane is oriented parallel to the exposed surface. This improvement is caused by the development of a macro-galvanic couple between the crevice and the non-crevice area, the intensity of which is lower if a less
close-packed plane is parallel to the surface. The correlation between the crystallographic nature of the exposed surface as obtained from the texture data and the crevice corrosion resistance has been established and is found to be in support of the above interpretation.

The effect of grain size and carbide precipitation (sensitization) has been studied in detail on 316 stainless steel. The $E_{cc}$ value or the resistance to crevice corrosion has decreased with a decrease in the average grain diameter ($d$) following a linear relationship between $E_{cc}$ and $d^{-1/2}$. The sensitized samples after the crevice corrosion showed intergranular attack inside the crevice as against no such attack outside the crevice and showed increased susceptibility to crevice corrosion. This is attributed to the chromium depletion at the grain boundary which creates more active sites for the initiation of crevice corrosion. The increase in the active grain boundary sites is also the reason for the enhanced crevice corrosion attack in the fine grained materials.

With a view to simulate the chemical and electrochemical changes occurring in the crevice during corrosion, 316 stainless steel specimens were exposed to solutions containing different concentrations of cations, chloride ions, and
hydrogen ions (pH) and anodic polarization studies were made. It has been observed that a complete breakdown of passivity leading to rapid crevice corrosion occurs when pH is less than 2.4 and the chloride ion concentration is more than 2.0 N. This observation supports the contention that crevice corrosion occurs when the solution in the crevice becomes aggressive and an active-passive cell forms between crevice and non-crevice area.