FROM DISCRETE TO SINGLE IMPACTS IN PARTICLE INDUCED FLOW CORROSION

A. W. Hassel, E. Akiyama and M. Stratmann

Department of Interface Chemistry
and Surface Engineering
Max-Planck-Institut für Eisenforschung
Max-Planck-Str. 1, 40237 Düsseldorf, Germany,
hassel@elchem.de

Erosion-corrosion is a typical type of tribocorrosion, which occurs for example in pipes and tubes carrying slurries. Due to a synergistic effect simultaneous mechanical and chemical attacks lead to a much faster degradation of materials than simply the sum of mechanical and chemical effects. During the last years, the birth of corrosion pits stimulated by slurry erosion [1] and the effect of the impact angle on the slurry erosion-corrosion [2] have been studied. In order to understand the effect of impingement attack of slurry on erosion-corrosion it is necessary to measure the individual erosion events under slurry impingements. In this study, a slurry jet system has been built and electrochemical signals have been measured under slurry impingement in order to investigate the current transient generated by a single particle impact. This work also attempts to understand the kinetics of repassivation of the metal surface of Al and Al alloys freshly bared by particle impact.

The slurry jet system that has been built is shown in fig. 1. The system consists of a slurry jet, a microelectrode, a sensitive high speed potentiostat suitable for measurements of small currents in short times, and a high-frequency data acquisition board whose maximum data acquisition frequency is 20MHz in a suitable computer. The slurry consisted of 0.1 M acetate buffer solution containing solid particles like SiC or quartz glass with a diameter of e.g. 100 µm. The particles were emitted from a nozzle to the surface of the aluminum microelectrode at a velocity of 4.8 ms^{-1}. The diameters of the microelectrodes were 125 µm and 500 µm.

Comparison of the repassivation process which lasts 5-10 ms between pure aluminum and an aluminum alloy containing 1% silicon demonstrated the faster repassivation of the alloy after impact of particles. The high frequency data acquisition allowed not only the separation of discrete impacts but also the analysis of the fine structure of the current transients as seen in fig. 2. The inset in fig. 2 is a magnification of the rising edge demonstrating that the activation time is about 50 µs.

A direct correlation of the measured current transients to the effect on the surface such as plastic deformation becomes possible if experiments are realized not only with discrete impacts but just a single impact per experiment. For that purpose a pump with the extreme acceleration of 30000 rs^{-2} was employed. It reaches its maximum speed of 6000 rpm within only 3 ms allowing short jets with only single impacts. The effect of the impacts can be than visualized by means of SEM.

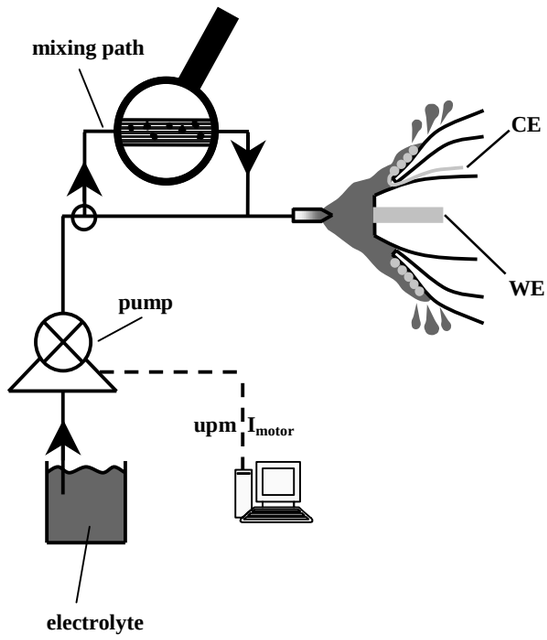

Fig. 1 Schematic of the slurry jet for detection of single particle impacts in particle induced flow corrosion.

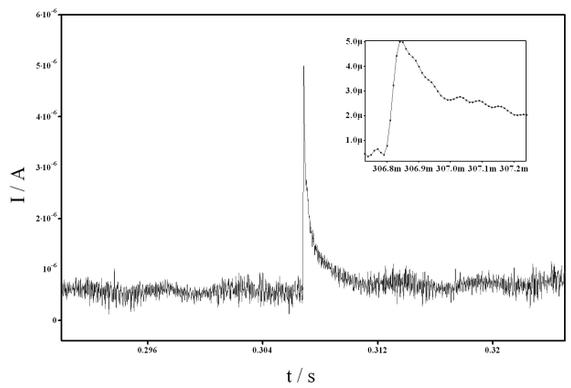

Fig. 2 Current transient of a single particle impact. A magnification of the rising edge is given as an inset.

References

[1] G.T. Burstein, K. Sasaki, Corr. Sci. **42** (2000) 841.
[2] G.T. Burstein, K. Sasaki, Wear **240** (2000) 80.