

Laser-induced Nanoscale Processes at the Solid-Liquid Interface

Wolfgang Kautek

University of Vienna, Department of Physical Chemistry

Währinger Strasse 42, A-1090 Vienna, Austria

E-mail: wolfgang.kautek@univie.ac.at; Internet: <http://pchem.univie.ac.at/>

Laser-induced processes at the solid liquid interface show specific features in respect to physico-chemical aspects differing strongly from the situation in vacuum or air. Thermal balances may vary and plasma piston effects are intensified. Electrochemical manipulation of such interfaces adds attractive possibilities to monitor corrosion, repassivation, ablation, microstructuring and cleaning processes. Laser-induced electrochemical processes at anodic aluminum, titanium and ruthenium oxides on the respective metal substrates are representative examples. Depassivation experiments with various wavelengths of nanosecond excimer and Nd:YAG-lasers allowed simultaneous recording of potential, current and charge in an electrochemical potentiostatic three-electrode set-up in aqueous electrolyte. This provided insight into the electrochemical processes of the active metals normally inaccessible in steady state electrochemical investigations.

Further, thermomechanical mechanisms of electrode activation of ruthenium/titanium mixed oxide electrode were studied. Laser irradiation of the absorbing oxide resulted in ablation. On the other hand, the transparent oxide was delaminated by the ablation action of the underlying alloy substrate (spallation). Current transients could be related to ion-conducting flaws generated mechanically in the shock-affected zone (SAZ). Ionic transport through the growing oxide or through the flaw channels controlled the repassivation rate. Once the alloy substrate was laid open by the ablation process, the amount of oxide formed during repassivation depended on the applied potential. The modeling of the current transients allowed insight into the physico-chemical interface dynamics.