Use of Advanced Electrochemical and Surface Analysis for the Development of New Generations of Self Healing Organic Coatings

Herman Terryn

Vrije Universiteit Brussel (VUB)
Research Group Electrochemical and Surface Engineering (SURF)
Department Materials and Chemistry,
Tel:+ 3226293537 (secr 3255) mobile 32478881705
hterryn@vub.ac.be
www.vub.ac.be/SURF

part time M2i Materials Innovations Institute
and Department of Materials Science and Engineering, TUDelft
Metals Processing, Microstructure and Properties (MPMP), Corrosion Technology and Electrochemistry,
Tel:31152782535 (secr)
www.m2i.nl

The concept of self healing materials is currently a fast developing research area in materials science with a wide range of promising industrial applications. Both regions, The Flanders and the Netherlands launched big research programs on this topic (www.sim-flanders.be/ and www.agentschapnl.nl/programmas-regelingen/iop-self-healing-materials/). Self healing concepts are built in traditional materials such as concrete, metals, ceramics, and composites. Additionally development of new generations of coatings is considered with self repair capabilities. Both labs at VUB and TUDelft are running projects on the development of new generation coatings that will have self polymer repair combined with a new generation of inhibitors. Several polymer synthesis [1] routes are explored making use of both non autonomous [2] (trigger is eg heat) as well as autonomous repair [3]. This polymer approach is combined with inhibitor selections making use of high throughput electrochemical investigations to tackle multi metal approaches (collaborative research with TU Delft - CSIRO-Australia) [4]. To study in detail the combined working principles of the inhibitor and the repair of the barrier properties in a created defect we are making use of complementary advanced local electrochemistry set ups such as Scanning Electrochemical Microcopy [5], Scanning Vibrating Electrodes [6], Scanning Selective Ion Selective Electrodes [7] and a local AFM combined with a new developed EIS approach [8]. This information is complemented with several spectroscopic and electron miscroscopy analyses. The overall approach will be discussed in detail making use of a thermo reversible polymer [8] systems developed at VUB. This physically cross linked polymer system shows a self-healing ability based on the fracture and reformation of thermally reversible physical bonds in the polymer matrix. Because heat is necessary to trigger and assist the healing process, these materials are classified as non-autonomic healing polymers. Additionally inhibitors were added to the coating formulation. As such the feasibility was shown that a multiple action self-healing coating system on a metal was feasible to create. Another system that was developed by TU Delft was the inclusion of self healing polymer capsules in an organic matrix that may work autonomously [3].

Acknowledgement The author acknowledge the SIM-Flemish partners of the project "NAPROM" and partners of University of Gent and Antwerp and of Tu Delft.

References

1) S.J. García, H.R. et al Progress in Organic Coatings 72 (2011) 211– 221
2) J.-B. Jorcin et al., Electrochimica Acta 55 (2010) 6195–6203
3) S.J. García, et al Prog. Org. Coat. 70 (2011) 142
4)) S.J. García Surface and Interface Analysis (2011) 205-210
5) Y. González-García, et al. Electrochem.Comm 13 (2011) 169-173
6) Y Gonzalez-Garcia, Electrochimica Acta 56 (2011) 9619-9626
7) A.Alvarez Pampliega accepted Electrochimica Acta on line
8) T. Breugelmans Progress in Organic Coatings 69 (2011) 215-218
9) G. Scheltjens Journal of Thermal Analysis and Coulometry 105 (2011) 805-809