TU Clausthal
Clausthal University of Technology

CPP47.1

Metal ions at metal/polymer interfaces

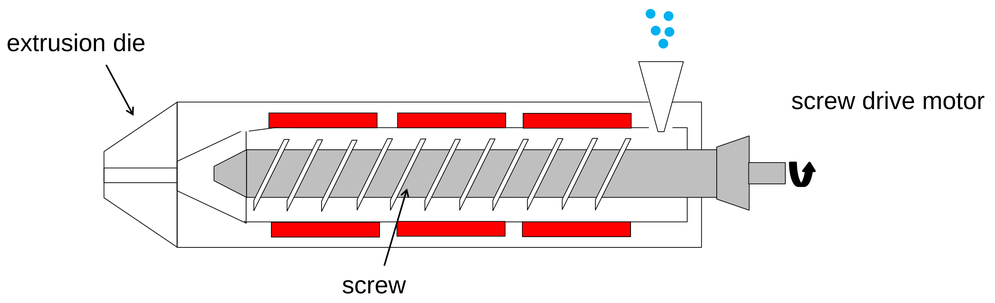
M. Sonnenberg[1,*], R. Gustus[1], L. Wegewitz[1], S. Sedelmeier[2], H. Vega[3], H. Scheerer[3], J. Wieser[2] and W. Maus-Friedrichs[1]

1 Clausthal Centre of Material Technology, Clausthal University of Technology,
Agricolastraße 2, D-38678 Clausthal-Zellerfeld, Germany
m.sonnenberg@pe.tu-clausthal.de

2 Frauenhofer Institute for Structural Durability and System Reliability LBF, Darmstadt University of Technology,
Bartningstraße 47, D-64289 Darmstadt, Germany

3 State Materials Testing Institute and Institute for Materials Science, Darmstadt University of Technology,
Grafenstraße 2, D-64289 Darmstadt, Germany

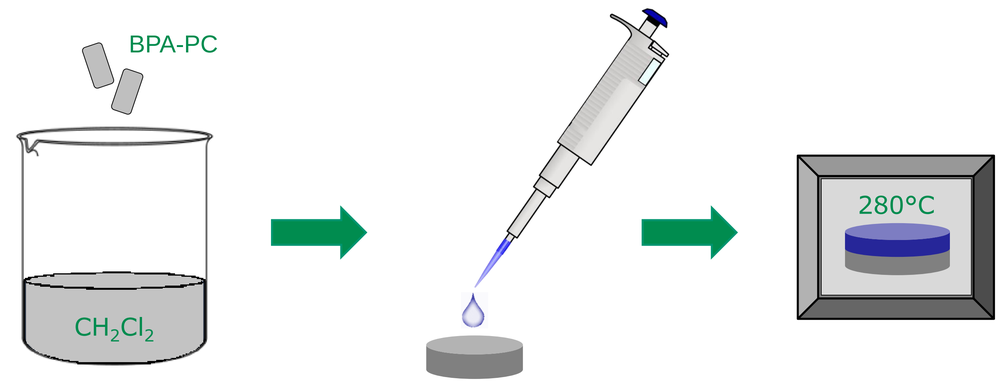
Introduction



Understanding the interaction between thin polymer films and metal surfaces is necessary for the plastics processing industry. During the processing of plastic, polymer is melted in the extruder unit. Often thin polymer layers are formed on the surface of the extruder, which leads to peeling off of partly solidified polymers into the melt. These polymer particles do not melt again and generate defects within the product. Basic understanding of these mechanisms is important in order to avoid steel/polymer interaction.

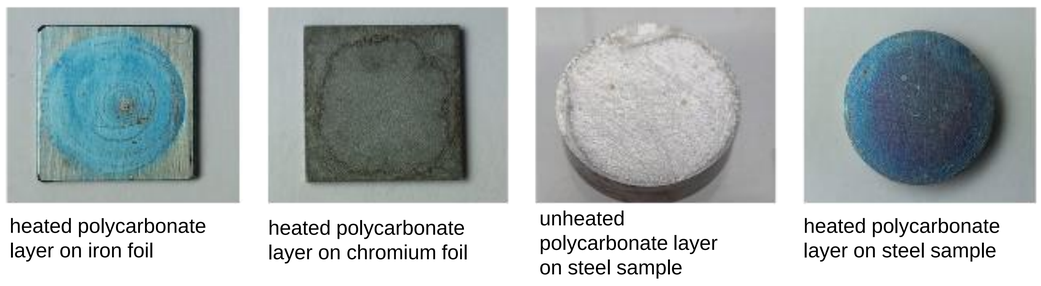
For this purpose thin layers of polycarbonate were prepared on different metal substrates and heated up to 280°C. The samples were examined by electron spectroscopic (XPS, AES) and microscopic (SEM, AFM) techniques. Experiments show that the diffusion of iron ions into the polymer melt occurs. Similar results could not be found for thin polymer layers on chromium substrates. A possible mechanism of iron diffusion and reaction in thin polymer layers is introduced.

Experimental



1. bisphenol-A-polycarbonate is dissolved in dichloromethane
2. preparation of thin polycarbonate layers by dropping the solution on different substrates
3. heating sample at 280°C under atmosphere

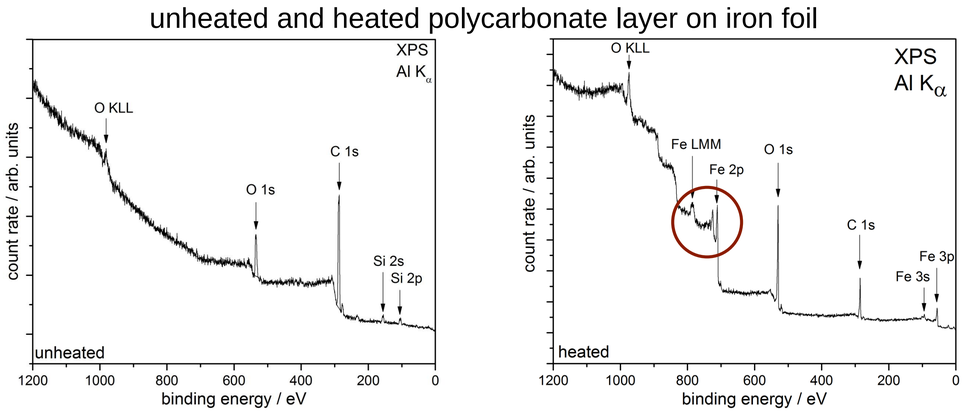
Sample Interfaces after heating



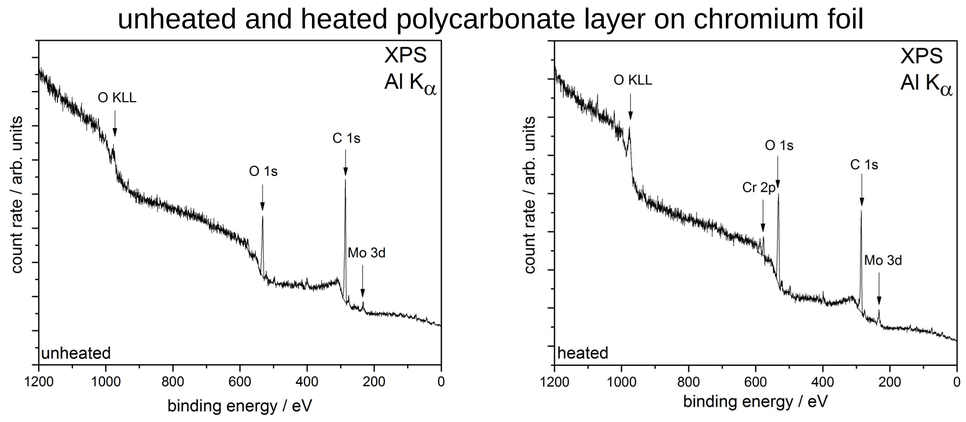
heated polycarbonate layer on iron foil | heated polycarbonate layer on chromium foil | unheated polycarbonate layer on steel sample | heated polycarbonate layer on steel sample

- blue colored layer of heated polycarbonate on iron foil and on steel sample
- colorless layer of heated polycarbonate on chromium foil
- colorless unheated layer of polycarbonate on metal foils and steel sample

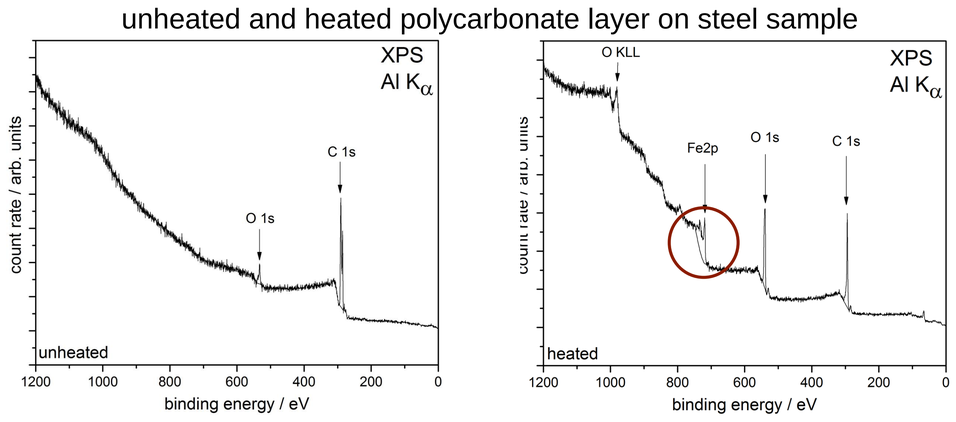
unheated and heated polycarbonate layer on iron foil



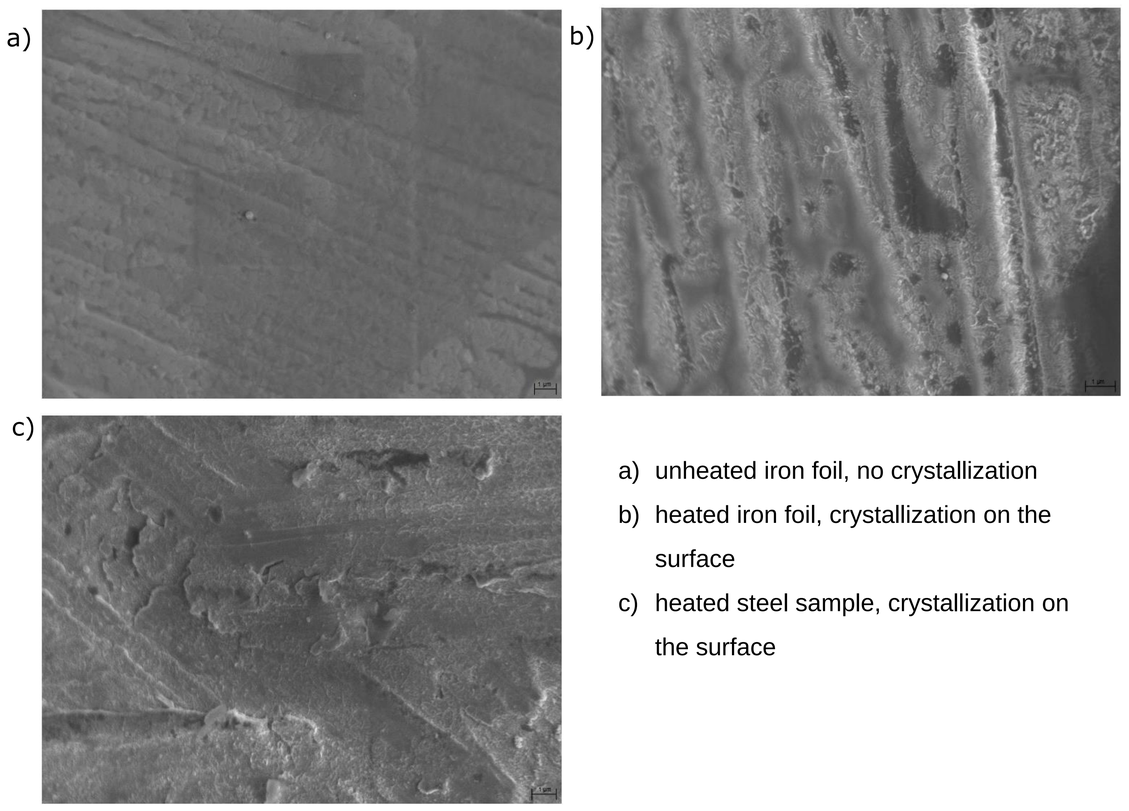
unheated and heated polycarbonate layer on chromium foil



unheated and heated polycarbonate layer on steel sample

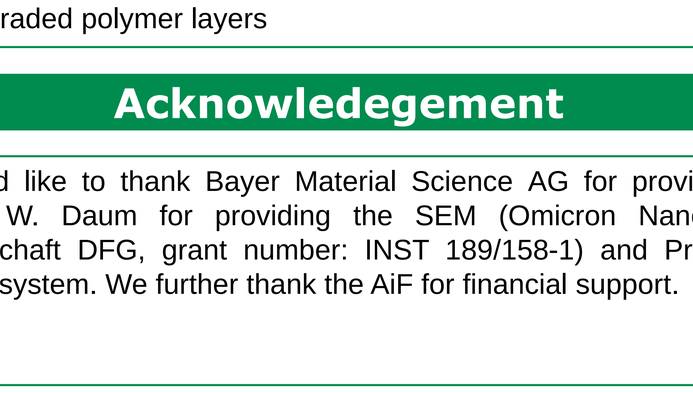


REM investigations on polymer surface



a) unheated iron foil, no crystallization
b) heated iron foil, crystallization on the surface
c) heated steel sample, crystallization on the surface

Mechanism of thin polymer layers forming on steel surfaces



Mechanism:

1. diffusion of iron ions in polymer melt
2. interaction between iron ions and polymer chains
3. entanglement of more polymer chains, formation of polymer layers on steel surface
4. thermal degradation of polymer chains
5. stripping of degraded polymer layers

Acknowledegement

The authors would like to thank Bayer Material Science AG for providing the polymer compound, Prof. W. Daum for providing the SEM (Omicron NanoSAM, Deutsche Forschungsgesellschaft DFG, grant number: INST 189/158-1) and Prof. F. Endres for providing the XPS-system. We further thank the AiF for financial support.