

# Application Report

## Protective polymer coating

Application report: AR218e  
Industry section: Construction  
Author: Hubert Lechner



Force Tensiometer – K12

Method: 

Keywords: polymer, anti-graffiti coating, wettability, dynamic contact angle, Wilhelmy, surface free energy

## Optimization of Anti-graffiti Coatings Based on Silicon-Hybrid Systems

### Abstract

Many monuments, made of stone, are degraded due to air pollution and human vandalism such as graffiti. Damage from graffiti also concerns present-day architecture as once soiled, these surfaces must be restored by repainting, sandblasting or washing with solvents. Such treatments change the look of the surface due to the physical degradation and are also labor intensive. Besides, it is useless because new graffiti appears some days later at the same place.

An alternative method is permanent protection of external surfaces by coating them with transparent polymer films with low wettability and good weathering resistance.

One possible solution can be a solvent-free film forming emulsion containing crosslinkable reactive polysiloxane [SIL] and polytetrafluoroethylene [PTFE]. With these stabilized emulsions (which also contain various non-ionic and anionic surfactants and a catalyst) a film can be obtained with polysiloxane-polytetrafluoroethylene semi-interpenetrating polymer network [semi IPN SIL/PTFE]. The proper design of semi IPN SIL/PTFE leads to a polymer film which shows excellent features of both polymers (high permeability of gases and vapors of SIL as well as low wettability of both polymers).

Several parameters like morphology, water vapor permeability, resistance to salts, frost resistance, UV resistance, dynamic contact angle and surface free energy have to be tested for optimizing SIL/PTFE ratio for best protective coatings in practice.

## Experimental

For water wettability evaluation, dynamic contact angle [DCA] measurements were made with a KRÜSS Processor Tensiometer K12 with software K121 using Wilhelmy method at 25°C. Samples were prepared by coating glass cover slides with tested emulsion and drying them over 48 hours. For detection of wetted length and dynamic contact angle samples were immersed and withdrawn in a liquid of known surface tension. For calculation of wetted length n-hexane as totally wetting liquid was used. Speed of movement was constant at about 4mm/min. Advancing and receding contact angles [ACA and RCA] were calculated by using regression method i.e. elimination of buoyancy by extrapolation to zero immersion depth.

Surface free energy values [SFE] were obtained on the basis of DCA measurements for water and benzyl alcohol using the geometric mean approach (Owens-Wendt equation).

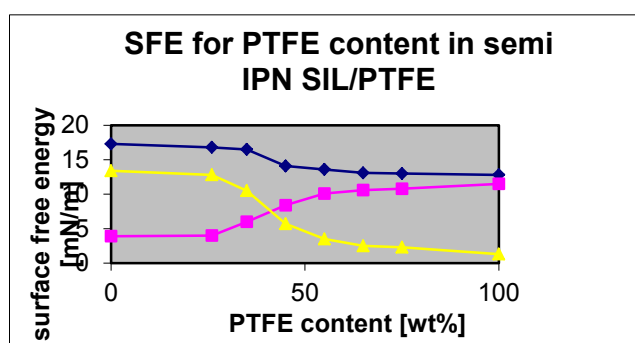
## Results

The following results from DCA determination with water were obtained for different ratios of PTFE content in semi IPN consisting of SIL/PTFE applied in the form of an aqueous dispersion:

PTFE wt %	0	26	35	45	55	65	75	100
ACA [°]	92,0	93,5	95,6	98,0	105,0	109,6	114,1	116,0
RCA [°]	83,9	83,4	85,7	82,3	88,9	89,3	90,2	92,0

For surface free energy, the following values have been calculated based on advancing contact angles of water and benzyl alcohol:

PTFE wt %	0	26	35	45	55	65	75	100
SFE [mN/m]	17,3	16,8	16,5	14,1	13,6	13,1	13,0	12,8
disperse part	3,9	4,0	6,0	8,4	10,1	10,6	10,8	11,5
polar part	13,4	12,8	10,5	5,7	3,5	2,5	2,3	1,3



Knowing the different molecular structure of PTFE and SIL it is clear that in such aqueous coating formulations increasing PTFE/SIL ratio results in increased water contact angle and decreased SFE value. As one can see,

even below a ratio 50/50 % the disperse part is bigger than the polar part, which means dispersion-type attraction already dominates over polar-type ones.

Results of DCA and SFE determination were in good agreement with ESCA measurements and mechanical application tests. This allows preselection of the formulation of semi IPN SIL/PTFE that will show good protective behavior in practice.

## Literature

- [1] M. Zielecka, 3<sup>rd</sup> International Conference Advances In Coating Technology, ACT 1998, Katowice (PL), Paper N° 19
- [2] D.K.Owens, R.C. Wendt: J.Appl.Polymer Sci. 13 (1969), 1741-1747

You can find many more interesting Application Reports on our website under

<https://www.kruss.de/services/education-theory/literature/application-reports/>