Nano Coatings

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Abstract - Future will show fascinating innovations at the development, formulation and application of industry enamels. Especially the following emphases at R&D and application are to be called:

- **Use of Nano corpuscles and other innovative filling materials**
- **Applicating Nano structures and layers**

This contribution attempts to register the essential nano-scaled innovations either how they are already to be observed today or announce to themselves.

In the next years essential innovations at the development and formulation of industrial coatings and paints will to be observed especially by the use of nano technology [1]. New findings of the physical and chemical basic research let appear the coatings-technical phenomena in another light.

What means “Nano” in the fields of coatings?

- Use of new physical instruments, methods and processesDevelopment, production and analysis of nano-sized materials (structures, layers, particles, linkings)The differences between chemistry, physics and biology disappear. Below a certain order of magnitude particles get new, "atomic" properties, influencing optical, mechanical and chemical properties of surface.

Nano Structures

Purposeful study at binders with increasing previous calculation instead of trial and error; new binders with tailor made properties and defined molecular structures. One example:
In particular the controlled radical polymerisation allows the construction of taylor made block and comb copolymers. The synthesis of strongly branched out polymers up to dendrimeres leads to binder agents with low viscosity in organic solvents as a basis for new High Solids systems and to new high-functional hardeners. [2]. Fig. 1 shows a starting unit for building up dendrimeres; fig. 2 shows a comparison of dendrimere construction with a normal linear polymer.

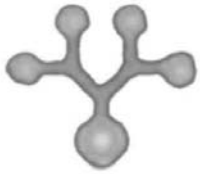


Fig. 1: Branching unit for building up dendrimeres

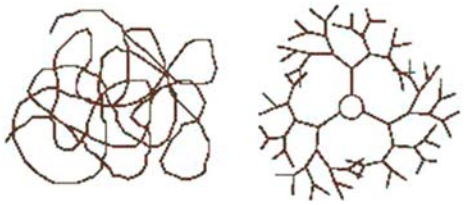


Fig. 2: Comparison between conventional (left) and dendrimeric polymer

Hybrid-polymers as next example for nano structure are used already and have a great potential for future coatings systems: Combinations of organic polymers and organically modified, inorganic silicates (fig. 3) [3]. Using them it becomes possible to add the good qualities of different polymer classes. The combination of inorganic and organic elements, in particular the mounting of silicon into the polymer structure, offers special advantages. Hybrid polymers combine the stability and scratch resistance of inorganic networks with the elasticity of the organic polymers.

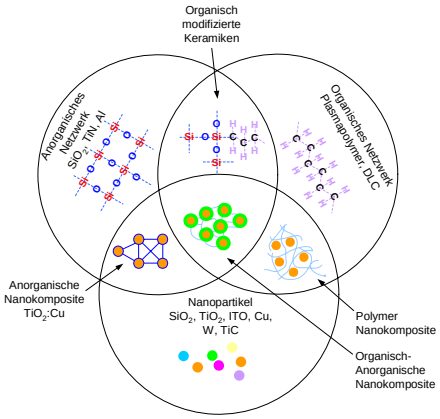


Fig. 3: Inorganic/organic network

And - among other things – they show good adhesion on glass with which they are suitable for functional glass depositions as a basis at best. Synthesis ways as the sol gel technique (fig. 4) are already since longer proven.

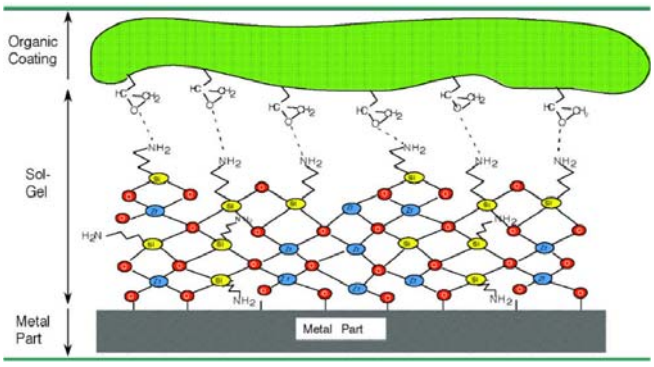
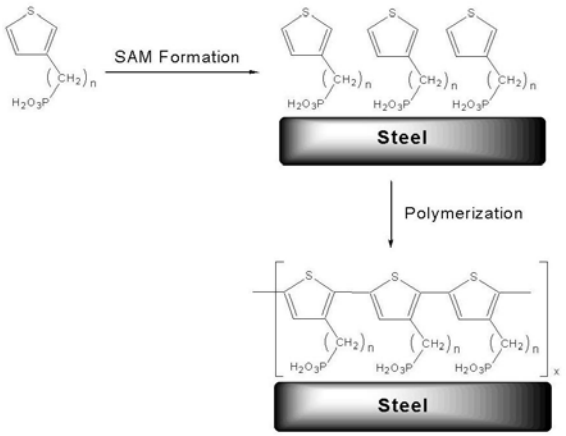


Fig. 4: Sol gel technique improving adhesion on metal

SAM´s: Self assembling molecules can arrange themselves on a (metal) surface in a very regular and close manner and then polymerise in a second step [4]. Fig. 5 shows this schematically. This very flexible, self healing up, strongly anchored layer may improve coatings adhesion, corrosion protection and mechanical and chemical resistance.

Fig. 5: Layer formation on a steel surface with self assembling molecules (SAM)



Improvement of surfaces by nano-particles [5]

These new particles (conventionally: pigments and fillers) cover a broad spectrum of improvements :

- More perfect surfaces
- Scratch resistance by imbedding of “ceramic” particles
- Antislip
- Info-implementation (like DNA)
- Optical or microbial effects (Ag),
- UV-absorption (TiO_2, ZnO, CeO_2)
- IR-absorption (ITO, others)
- Antiadhesion-coatings for glass, ceramics and metals
- Easy-to clean surfaces, reducing dirt
- Photocatalytics
- Sol-gel-techniques

Filler materials as layer silicates or SiO_2 are set in qualities' today mostly specific to the cost reduction and reaching certain properties in paint formulations. Specific filler materials will occupy in future more and more also the role of additives that are set in purposeful to quality improvement and strengthening of the surface.
Nanocorpuscles and nanolayers offer a very innovative chance of that. The only few atoms big particles show up to now hardly known quality profiles. Imbedded into the polymer matrix of the binder surface coatings which ultrathinly, permanently strongly, translucently and chemically constant can be produced with that. Fig. 5 shows schematically the imbedding of small diamond particles as antislip agent, fig. 6 a SEM-picture of these diamonds standing out from the coating surface.

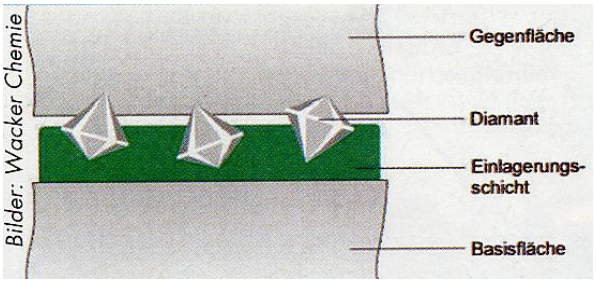


Fig. 5: Scheme of diamonds imbedded for slip reduction [6]

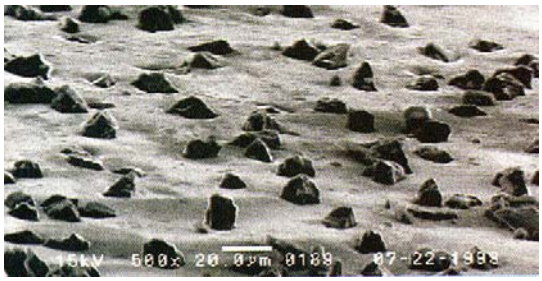


Fig. 6: SEM-picture of a surface, acc. to fig. 5

In particular phyllosilicates, however, also $Si0_2$ that are unlocked nanofine in polymer solutions or polymer dispersion correct the mechanical qualities, for example the scratch resistance, as components of depositions. Or they control the rheological properties of the fluid paint without damaging qualities as gloss or transparency. Phyllosilicates dispersed in nanofine form increase the barrier effect of coatings considerably. They will find use as gas diffusion closures for example with drink bottles or hose materials. Here they seem also as an efficient closure against the CO_2 -loss. Also the use for electroinsulation, for thermal insulation, for fire protection and to antistatic outfit of surfaces is known. Further examples: Anticustody depositions for glass, piece of pottery and metals as well as in polymers, that prevent dirt-, water- or oil-covering .

Micropatterns, made purposefully by coating on surfaces, favour the run off behaviour of water and the entrainment of dirt particles. This so-called "Lotos effect" (fig. 7 - 9) was copied after the nature by the Botanical Institute of Bonn University and is brought already into self cleaning roofing tiles and sanitary subjects. The use on bright surfaces as on cars is discussed again and again, not appearing however realistic at the moment. The hardest problems are the sensitivity against cleaning, brushing and other mechanical treatments and the fact, that the artificial lotos surfaces are not self renewing like the natural leaf.

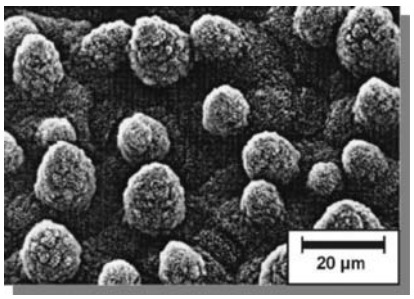


Fig. 7: Surface of a Lotos leaf [7]

The controlled emission of substances from coatings is set in already today for the vegetation pollution prevention, antifouling e.g.. It can be used in future also for the operation of reactions at coated surfaces. Microporous coatings donated with catalysts can contribute to the decontamination of environmental damaging-gases, in the same way photocatalytically effective layers.

(Quelle: Sto AG)

Just the border crossing conversion of scientific findings offers the paint industry a large innovation potential. During the itself cleaning surface always further advances into the paint sector and improves products considerably, developments already suggest to themselves in the labs, that open an even further application field to ultra thin layers. Photochromic coatings for example, which are translucent according to light intensity incident or -dense. And coatings equipped with catalysts could add one day to the removal of pollutants in the air.
Finger prints in paints: Built-in theft protections, for example with codification as in genetic material, are supposed to guarantee in future individual assignments of coatings to the owner. They could determine the agency responsible also in case of car accidents. This is possible by addition of smallest amounts of components to the paint during an application.
Holografic structures also lead to interesting colour effects. At the development is worked by investigating such holografic effects influencing the colouring of coated surfaces.

Nanofuture

Some further trends are in development, not yet in the market:

- Photovoltaic Surfaces: High-flown project, up to now only 1000 W per car
- Electronic selectability and color switching
- Nano-coating of windshields and other high-tech glasses (already used for some applications)

Nano components will gain generally importance for the enamel development, after climbing the step from nano science to nano technology. New raw materials will result in using coatings more than up to now as functional layers.
The above presented utilization and processes point out it: The nanostructuring of thin film systems as well as the use of nano-scaled particles will revolutionize the industrial shift and surface technique basically.

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