The best of both worlds

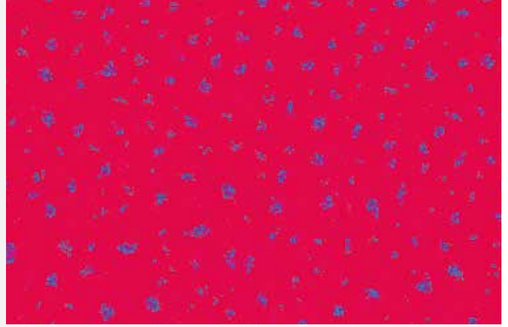
Paint on a wall should not only be nice to look at: it must be easy to apply, durable, prevent algae and mould and help maintain a good indoor climate. The key to this is the binder, which holds all the components of a paint together. Researchers at the FHNW HLS have developed a new molecular link between the building blocks of two conventional paint binders. The result is a new binder that combines the advantages of its two source components to produce versatile wall and façade paints without biocides.

House façades should look fresh, be attractive in the long term and not be vulnerable to microorganisms. To this end, most façade paints contain biocides, but these are washed off into the groundwater during storms, endangering water and soil organisms as well as our health. "Silicate paint is different," says Michel Ledeur, head of the research laboratory at vanBaerle, a cooperation partner of the FHNW HLS. "Silicate paint does not require biocides or solvents and looks almost as good as new even after decades. A good example of this is the façade of the historic town hall in Schwyz; it has been there since 1891." But because silicate paint only adheres to a few substrates, vanBaerle wanted to combine its advantages with those of emulsion paints – a well-known type of paint widely used on walls. Hence the company developed a new binder in collaboration with the Institute for Chemistry and Bioanalytics (ICB) at the FHNW HLS.

"Thanks to the molecular adapter we have developed, there is now a paint binder that consists of mineral and organic polymers simultaneously."

Uwe Pieles

"The binder combines the various components into paint," explains Ledeur. "It ensures that colour pigments, thickeners, defoamers, dispersants, fillers and water blend into a single mass that you buy as paint in the DIY store." In silicate paints, the binder is based on potassium silicate. Dispersion paints on the other hand contain an organic binder – often acrylic-based, as with artists' paints. The binder plays a key role in determining the properties of the two types of paint, as Ledeur explains. "The secret behind silicate paint is that it cleans itself by losing a few micrometres through abrasion every month. Nevertheless, it adheres very well because it bonds with the substrate through a chemical reaction. Moreover, it is insensitive to sunlight, and rainwater simply rolls off it." Dispersion paint, on the other hand, scores with versatility and user-friendliness: it can have a wider range of colours since, unlike silicate paints, organic pigments can be added to it. In addition, emulsion paint adheres to a wide variety of surfaces, it is less brittle and easier to apply.



To get the best features of both types however, you cannot just mix them because their binders do not work together. "Mixing acrylic binder and commercial silicate binder gives an uneven mixture of glass chips and plastic," says nanoscientist Uwe Pieles from the ICB. Although Pieles' team showed that a specially developed silicate increases compatibility with the acrylic binder, there was still no direct bond between the silicate and acrylic molecules. The researchers at the FHNW HLS created this missing bond in collaboration with vanBaerle's research and development department. "You have to think of it as an adapter that links the silicate and acrylic polymers both physically and chemically," Pieles explains. "When we add it to the silicate-acrylic binder mixture and look at it under the electron microscope, we see a homogeneous material in which the silicate molecules are evenly surrounded by acrylic polymers thanks to the adapter bonds."

The researchers ran a series of practical tests to investigate whether the new hybrid binder really combines the positive properties of its two basic components. For example, they wanted to see how well the hybrid binder adheres to different surfaces; to do this, they painted it on test surfaces and exposed it to wind and weather for several days. "Our new organo-mineral binder performed as well as silicate paint on mineral glass surfaces and even better than emulsion when applied to organic paint," says Ledeur. The hybrid binder can therefore be used on almost any substrate, whether plaster, brick or even directly on top of an old coat of paint. Just like silicate paint, however, it needs time to cure in order to achieve its best adhesive properties. Once it is completely dry, it no longer absorbs water, even when a test panel is submerged for three days. As the research team has demonstrated in electron microscope images, the silicate content in the hybrid binder also means it penetrates into painted surfaces, making the finish very durable. In addition, paints with the hybrid binder can absorb and release moisture from the air in a similar way to silicate paint, allowing walls to breathe and preventing mould. A final advantage is that the high pH value of the hybrid binder counteracts the growth of microorganisms, making biocides unnecessary.

Ledeur calculates that it will take at least another year before paint with the new binder is launched on the market, since manufacturers first have to develop suitable formulations and test their colours. But the breakthrough has been achieved: a hybrid binder created for durable, environmentally-friendly and safe paints for exterior walls and interiors.

Methods and infrastructure
- Chemical laboratories
- Synthesis equipment
- Electron microscopy
- Headspace GC-MS for the determination of volatile components
- Thermogravimetry

Support
- Innosuisse

Collaboration
- vanBaerle AG