radical!

When titanium dioxide was first 'discovered' as a paint pigment in the mid 1930s it was considered revolutionary, as its ability to obliterate was a quantum step ahead of the (then) current technical leader - zinc sulphide. Revolutionise the industry it did but it was not without its drawbacks. When used in exterior paints, it caused the early onset of 'chalking' - that film degradation that leads to loose, unbound pigment on the surface.

The Americans, brilliant at turning negatives into positives, successfully sold such paints as 'self cleaning paints' but one wouldn't want to lean against such a surface in a dark suit!

The reason for the early 'chalking' was because of the nature of the pigment itself. It was first produced in a crystal form called 'anatase' and, when U.V. light hit this crystal, the crystal absorbed it. However, because of the semi-conductive nature of titanium dioxide, the energy absorbed from the U.V. light was emitted in a form of chemical energy called a free radical. These free radicals, acting over a short distance, degraded the organic binder and resulted in 'chalking'. The titanium oxide itself is not degraded and the phenomenon is referred to as photocatalysis.

Researchers developed methods of producing titanium dioxide in another crystal form called rutile, which had a double benefit. It was much less photoactive (only 30% of that of anatase) but also had even better hiding power. The direction of the titanium dioxide industry became set; increase the degree of rutilisation and, by clever encapsulating techniques using other metal oxides, reduce the photocatalytic activity and increase the durability.

As mentioned in an earlier memo, the particle size of titanium dioxide is controlled to half the wavelength of visible light to maximise the hiding power. If one reduces the particle size, its hiding power gets less and less, until, at sizes around 100 nanometres and lower, it becomes transparent. This may seem to be defeating the purpose of the pigment except that, even at these low particle sizes, it does remain an efficient absorber of U.V., which is useful for such things as sunscreens and U.V. absorbers in clear films.

As one reduces the particle size of a material there is a corresponding increase in the surface area and maintaining the degree of rutilisation and encapsulation of these ultrafine particles became a real challenge. Then some bright spark had a really brilliant concept. She (or he) realised that the ability to 'blat' organic materials with free radicals could be a very useful thing if those organic materials were dirt, pollution, bacteria and viruses even. "Let us produce superfine (nano) particles of anatase titanium dioxide with lashings of surface area, oodles of surface photocatalytic activity and let us attack grime and stuff."

The concept works brilliantly being used in self-cleaning glass; traffic fume re-circulating systems; 'smog-eating' concretes and plasters and, particularly in Japan, domestic air purifying TiO^2/U.V. lights.

The potential for use in paints exists but with a few challenges. Apart from the challenge of getting these very fine particles dispersed throughout a paint, the tendency of these very active particles to blast typical organic paint binders to 'kingdom come' was also tricky. The other issue was that these systems were activated by U.V. light and many of the potential uses for such paints are indoors. Our challenge as a paint manufacturer was to come up with suitable binders and, thankfully, the pigment manufacturers came up with a way of 'doping' their pigment such that the photocatalytic activity can now be triggered by visible light.

We, Resene, have been engaged in this area for several years and we now find ourselves in a tricky marketing area! We have developed a product which we believe can make a positive impact on our environment - but quantifying it is difficult. European testing facilities tell us that our technology works but we are not going to claim that we are going to save the world. We are initially going to target underground garages and carparks as obvious areas where this technology could make a very positive impact and look forward to the feedback that we will undoubtedly get from those very fertile minds out there.