ARCHITECTS MEMO

by Colin Gooch, Resene Technical Director

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turn on the night light

Luminescence has always fascinated large numbers of us - as a kid, I couldn't wait until it got dark so that I could look at the radiant dial of my first luminous watch. More romantic souls have been fascinated by glowworms, fireflies, the phosphorescent ripples of tropical wavelets, the auroras (Borealis and Australis) to mention but a few.

A dilettante's review of the subject would reveal that there are about half a dozen different mechanisms that produce luminescence but this memo will confine itself to photoluminescence. Normal light is always associated with heat and the fact that, as a substance is heated, its individual atoms get very agitated and release most of the newly acquired energy as light. The hotter the material gets, the brighter the light that is emitted until the material becomes 'White Hot'. Luminescence on the other hand, produces light without significant heat input. The way it happens is very, very intriguing.

On being bombarded with photons the outermost electrons surrounding the atoms in a photo luminescent crystal or pigment become very agitated and get raised to an excited state (perhaps under 18s should stop reading here!). They leave their friendly orbit, leaving an 'electron hole' behind, and roam as a singlet exciton. In this quantum world, the singlet state is not very satisfying and the excitons can decay, emitting a photon, after a life span of about 10^{8} seconds. This may seem to be a very ephemeral life but it does give us the phenomenon of 'fluorescent' pigments.

In true phosphorescent pigments, the story becomes much spicier! The singlet excited electrons enter into a 'ménage a trois' (I warned you under 18s!) and they enter what is described in quantum physics as a 'forbidden energy state'. In this state these triplets wander around the pigment crystal, often getting ensnared in electron 'traps', for a quantum eternity until they find a free quantum hole to collapse into, giving up their de-stabilising photons.

The first recorded investigations of synthetic photoluminescents were done, in 1603, by the magnificently named Vincenzo Bascardiolo in Bologna. Vincenzo, an alchemist and a cobbler (what a fascinating combination of vocations!) who heated a mixture of barite and coal. The powder obtained after cooling exhibited a bluish glow at night, which could be restored by exposure to sunlight. What had formed was a barium crude sulphide.

Sulphides, in the form of zinc and cadmium still form the bulk of the photo luminescence market today.

Even from the earliest days, it was realised that the best luminescence was never obtained from the pure compound, but by materials having serendipitously included impurities - and this insight, less the serendipity prevails today.

The major advance in the field occurred in Japan in the early 70s with the discovery that certain alkali aluminates provided a very useful base material for photo luminescent pigments. Following the 'heads up' given by the cobbler, a thorough investigation was made to find the right impurity or 'dopant'! The exotic materials europium and dysprosium proved to be the best, providing the dual function of encouraging the roving electrons to leave their nest, but also providing new nests which encouraged them to give up their photons when the time was ripe. They also became skilled in introducing 'lotus land' flaws in the crystal where the triplets could carelessly while away many pleasant seconds, delaying the emission time of the photon.

The manufacture of these materials is by a melt process and the technology is so precise that the dopants need to be precisely spaced within the base crystal, effected via the use of fluxes. Particle size is critical as is the need to manufacture precisely. Contamination from even stainless steel vessels can 'poison' the luminescence. Formulating with white and tinters is also an absolute no-no!

The formulated products themselves are quite simple to use although it is strongly recommended that they are applied over a white undercoat for maximum effect. The performance of these products is primarily based on the quality and amount of the pigment used. From trivial (but nice) stencil paints for a kid's bedroom ceiling to a high-build safety paint for use in a power cut, you really do get what you pay for.

Now, if you'll excuse me, I'm going to turn out the light and bask in the afterglow!

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