EPTAINKS

Smart ink for effective light handling

An innovative transparent ink for screen printing on plastic and glass, visible only when enlightened by coloured LEDs.

The progresses that were and that could be obtained in the photonic and optoelectronic fields increasingly depend on the development of new functional materials that are characterized not only by outstanding performances, but also able to be integrated in optical devices.

Since the beginning of the last century, polymers have proved to be the most flexible solution for the market in terms of physical properties (electronic, mechanical, optical, etc.), characteristic lightness and versatility of use. In fact, polymeric materials can be molded, extruded, casted, brushed, sprayed, ink-jetted, and so on, resulting in objects with tunable size, thickness and shape, as thin film, bulk or fiber, according to the end-user needs.

STATE OF ART

Within the context of intense technological fervor of the last decades, the research focused on the development of new polymer materials with improved optical and opto-electronical properties, such as the high increase or decrease of refractive index, IR or UV absorption, tunable light diffusion and photoluminescence in suitable spectrum regions.

An emerging interesting application of these materials concerns their use as efficient diffusers of solid-state light sources (LEDs), which are more efficient in terms of electricity to light conversion than the conventional light bulbs. On the other hand, apart the well-known energy-saving and environmental advantages of this outstanding technology, the very small size of the LED chips presents critical issues for the punctual nature of the source and the eye-damage due to the resulting high-brightness.

In order to avoid these problems, suitable optical diffusers have been developed in the last decade. Two distinct types of optical diffuser screens are recognized, namely, surface-relief and volumetric type. Surface-relief diffusers are characterized by microstructures on the surface, while the volumetric ones are based on micron-sized beads uniformly dispersed inside the matrix, to scatter the light. However, in both cases, the use of micron-sized objects results in reduced light transmission compared to scattering, losing transparency. Moreover, the size distribution of the beads becomes a critical parameter. Much better control and improved transparency are obtained by using particles with a size comparable to the wavelength of the light (hundreds of nanometers), providing a more efficient and technological solution, although an homogeneous dispersion at a nano-scale level is a challenging topic.

Nanocomposite materials, namely organic or inorganic matrices containing nanometric particles, have met considerable attention in the last decades thanks to the possibility to modify the physical properties of the main phase with a doping amount of suitable nanostructures.

The market has already taken advantage of this knowledge by proposing nanocomposite large-area sheets based on PMMA. On the other hand, this technical solution shows several limits. The main

one is the inflexibility, for which the panel can be cut in the desired shape, but it does not allow a smart handling of the diffused light, in terms of amount of extracted light and design.

EPTAINKS APPROACH

Starting from this awareness, EPTAINKS R&D Department have developed a polymeric ink based on inorganic nanostructures that works as a super-efficient optical diffuser.

The main advantage of using an ink, instead of an extruded panel, is the freedom in managing the light in terms of design and size of the printing area and the chemical nature of the substrate. In fact, two kind of **Light Diffusing Inks (LDIs)** have been developed: one for plastic (mainly PMMA and PC) and one for glass, according to the application of the solution. This means that EPTAINKS has envisaged all the possibilities that the market could imagine and demand.

FEATURES

The property of LDIs is that the ink is **visible only through a dedicated LED illumination**: the printed image (by screen-printing) is in fact invisible in natural/artificial light condition or without any lighting, turning coloured only when the LED source, located at the edges of the chosen transparent substrate, is switched on.

The potential of this product and its practical applications are numerous and particularly interesting in the **Signage, Habitat and Mobility Industries**.

APPLICATIONS

Shop windows printing, for example, could benefit from the LDIs to create appealing graphic artworks having a strong visual impact, that are able to distinguish themselves and attract the customer's eye in an already overcrowded environment.
At the same time, the opacity problem caused by stickers or decals, which are an obstacle to the natural light crossing and are one side visible only, is overcome. Thanks to this ink, you are also able to create **complex designs**, achieving **animations** on the surface through intermittent lighting. Figure 1 shows one potentiality of the ink that has been used to create a signage.

Fig. 1: An example of an effect that can be achieved with LDIs, by printing the EPTAINKS brand name on an optically transparent substrate. The printing is invisible when the light is turned off (see the image on the top left), while it turns visible when the light is switched on. The writing assumes the colour of the LED source and, for this reason, the user can manage the effect by playing with the light.

Even in the Habitat Industry, LDIs applications are innovative and have a great potential, both functional and aesthetical. Applications include the printing of **transparent doors and walls**, which become enlightened bodies having an increased communication impact and providing **a higher safety** to people.

Some uses could be the lighting of doors when a meeting is held in a room, the **decoration of staircases and side surfaces of moving staircases**, e.g. in malls, to enhance the brightness of the environment with an immediate aesthetic impact, as well as the lighting of a pedestrian path.

TRANSPARENCY AND LIGHTING BY SAINT-GOBAIN

Thanks to the co-operation with an important provider of glass substrates, such as SAINT-GOBAIN Building Glass, it will be possible to answer all the customers' demands, from the printing of glass to the building of the final object, which the printed substrate and the light source have been suitably coupled in. Figure 2 shows a case-study in co-operation between EPTAINKS and SAINT-GOBAIN.

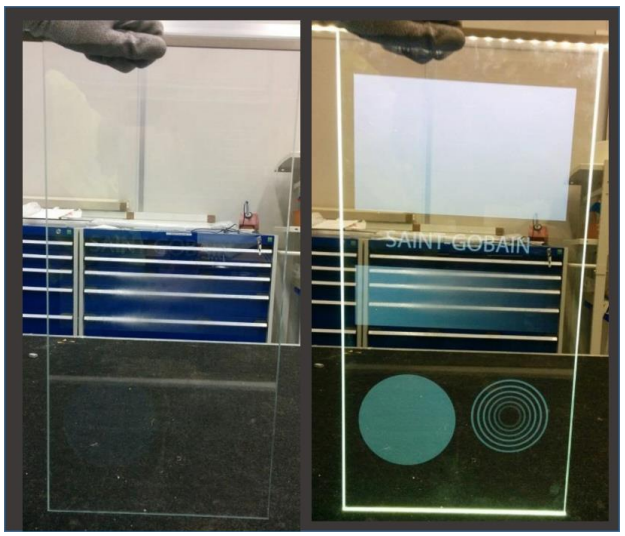

*Fig. 2: SAINT-GOBAIN exercises, from which it is possible to highlight LDI features. On the left side, it is possible to see the transparency of the printed ink on the glass substrate when the LED source is switched-off. On the right side the LED light is switched-on allowing to see the printed image. Homogeneous full images, degrades, and a writing have been printed on an optically transparent glass substrate (about 30cm*70cm), by using the same screen and ink. A different effect in terms of light diffusion could be obtained by changing the mesh of the screen and the dilution of the ink.*

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