

## Luminescence effects in the silk screen printing

*Nowadays luminescence meets us at many places, without we are aware of that immediately: With the turning on of the office lamps, with the new plasma television or at the work on the computer screen. Also credit cards, envelopes, documents and brand products contain luminescence material to distinguish, for example, originals from forgeries; high-quality watches, modern instrument foils, control switches or attention-catching displays - all these technical applications do not get by without luminescence features.*



### What is luminescence?

The concept luminescence is derived from the Latin *LUMEN* = cold light. The phenomenon of the luminescence occupies the humanity already since the antiquity. To us from this time many papers are known which specify luminescent features of various materials.

Generally one understands by luminescence the phenomenon with which material a form of energy absorbs and delivers back again as electromagnetic radiation. The electromagnetic radiation which is delivered by luminescence materials is mainly in the visible chromatic spectra of the light and appears to us as cold lights.

The luminescent processes can be divided by the type of energy addition. The most important variations are:

- **Electro luminescence:** The emission of light is caused by putting on an electrical field.
- **Thermo luminescence:** Rise of the energy concentration of an electron by thermal effect.
- **Radio luminescence:** On this occasion, energy particles are shot from the outside in suitable material.
- **Chemo luminescence:** With this form of the luminescence a chemical reaction delivers the energy to lift the electron in a higher energy state.
- **Photo luminescence:** Here the electron is stimulated by optical suggestion (radiotherapy).

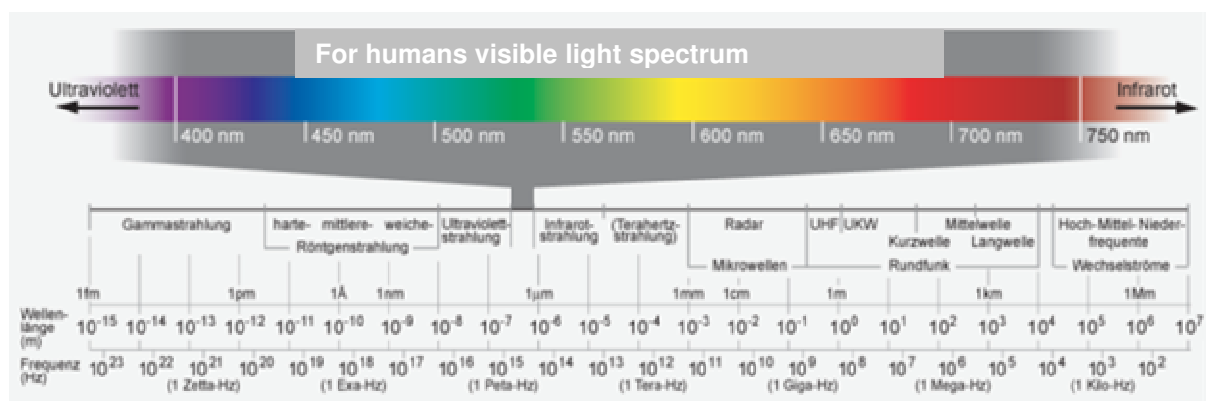
We more exactly want to have a look at this luminescence type subsequently.

All these forms of energy always serve to raise electrons in energetically higher states. If the energy addition stops, the electrons from the higher states fall back in unoccupied, energetically deeper states. Then the energy difference is delivered as a radiation energy ( $\Delta E = h \cdot \nu$ ).

## Physics of the light

To be able to understand more exactly the optical phenomenon of the photoluminescence, one needs some knowledge of the electromagnetic radiation. The electromagnetic radiation is to be associated after the wave particle dualism not unambiguously to one single theory. Therefore, in practice one helps himself with the theory with which the given circumstances can be characterised most clearly. With luminescence properties and many other optical phenomena the wave theory than turns out useful.

Therefore, the electromagnetic radiation is a coupling of two shafts crossed into each other (an electric one and a magnetic component) which spread out with steady speed of light. Electromagnetic shafts have a certain length which is designated wavelength and is defined as a distance of a wave mountain to another (or a valley on the other hand). The scale of the wavelengths reaches from kilometers (radios) up to few nanometers ( $\gamma$  radiation).



Electromagnetic shafts are shown in her frequency how it is usual in physics for oscillations. The conversion occurs with the easy formula:  $c = \lambda \times \nu$  ( $c$ : Speed of the shafts > speed of light;  $\lambda$ : Wavelength;  $\nu$ : Frequency)

The electromagnetic shafts carry energy which is dependent of the respective frequency of the radiation. One speaks of highly energetic radiation with high frequency and of low-energetic radiation with low frequency.

For the explanation of the photoluminescence the light spectrum visible for the human eye of from 400 to 700 nm including the ultraviolet and infrared connection ranges has a special meaning.

## Emission and absorption

With the luminescence models interesting us the required energy is emitted in the form of radiation by a light source. This light owns completely certain frequency or wavelengths.

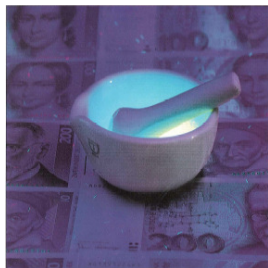
Because every emitted light contains only one choice of wavelengths the spectrum is not continuously distributed about all wavelengths. If one describes the spectra of emitted light, one speaks of emission spectra. If one describes light which is absorbed, one speaks of absorption spectra.

By the use of luminescent colors it is important to define the wave band necessary for the suggestion (emission spectrum). If this suggestion spectrum lies, for example, in the UV range with from about 320 to 360 nm, it is to be produced possibly luminescent colors which are invisible under daylight and show only by lighting with suitable UV lamps a visible color in the range from 400 to 700 nm.

Same counts to special colors which are stimulated in the invisible Infrared range and emit then in the visible range. These so-called "up-converter" are seated predominantly in the range of security application and protection of trade marks. Hence, the production and delivery are defeated by especially strict regulations.

## Demarcation of fluorescence and phosphorescence

A luminescent object emits light if it is stimulated by one of the mentioned energy sources. The different kinds of the originating luminescence can be separated by the duration of the lights against related effects. If an immediate radiation of the absorbed energy occurs one speaks of fluorescence. While phosphorescence describes a lag of second at least 1/1000 after turning off the light source.

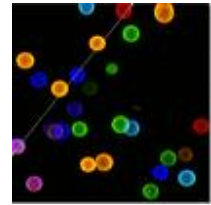


Therefore, a phosphorescent product also delivers after removal of the energy source furthermore light. This phenomenon is designated as a rule "post luminous effect". One can understand phosphorescence also as a delayed fluorescence. This can show a post radiation from several hours up to days. We have dealt with the post luminous effect already in detail in the Printcolor Newsletter from May, 2006.

## Photo luminescent silk screen printing colors

With these special printing inks it concerns the standard systems which were developed in relation on a defined property profile. Nevertheless, they contain, in addition, inorganic or organic fluorophores which lend them the desired photoluminescence property.

**Inorganic fluorophores** often consist of raw materials like crystalline zinc sulphide or oxide of the rare grounds metals which receives special optical properties by a special doping with so-called assets gates. On account of her source matrix these fluorophores behave like pigments. They are not dissolvable in the binding agent, are well stable against external influences and the price is in the low end.



**The organic fluorophores** behave like dyes. They completely come dissolved in the binding agent and have a very distinctive glaze. Colors can be thereby produced which are nearly invisible in the daylight and show under the illumination with UV light a very strong color. Unfortunately, these properties walk along with a little lower resistance profile. The prices lie in the middle range.

A completely **new chemistry** led to pigments which unite the good resistance inorganic with the persuasive optical qualities of the organic fluorophores. These new products lie on account of the very complicated synthesis in the upper prize range and are thereby planned exclusively for applications in the security segments.

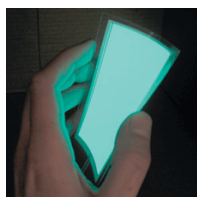
### Customer projects

On account of the very different requirements, applications and security aspects, Printcolor offers no assortment of the shelf. We work out with pleasure individual solutions, partly on exclusive basis, for our clients. The most important criteria for such elaboration are:



- Functional property of the ink system in view of the application.
- Type and spectral range of the light source to initiate the color shift.
- Desired cold light color.
- Resistance against physical or chemical influence.
- Devices and technology for detection and verification.
- Security requirements and customization.

We have developed on the basis of our practice-experienced components already many successful solutions in the applications Credit cards, Protection of trade marks and Product integrity. We make available our know-how to you with pleasure. Besides, we deliver not only application designed printing inks, but also consult with the optimum configuration of equipments and devices for the verification of security elements or also in the fluorescence-based automation technology. This is an important application with the tasks sorting, recognizing and verifying in fast running processes.



***If you already run existing projects, or if you have come on new ideas with the help of the application examples – respond to us. With pleasure we consider together how we can transform your wishes and requirements in successful products.***