Easily Legible and Durable Inscriptions

Masterbatches for Laser Marking

Laser marking systems continue to be on the advance. However, using them for inscriptions is not always simple for all applications. In particular, colored or translucent components frequently present problems. These difficulties can be overcome by means of masterbatches specially developed for laser marking.

Easily legible and lasting inscriptions are essential to ensure the traceability and identification of products. In many cases, laser marking systems are superior to other techniques such as inkjet printing or embossing. For example, inkjet printing is difficult on problematic surfaces, e.g. fluoro plastics. Nonetheless, also laser marking systems can be faced with problems; particularly where color is involved or the components are made of translucent materials.

To overcome these obstacles, Fietz Polychromos GmbH, Burscheid, Germany developed special additives for inscriptions with laser marking systems. Named "Laserwrite", these additives are combined with color pigments to create special masterbatches that are precisely matched to the applications. The additives compositions differ, depending on whether they are to be used on translucent or opaque bodies.

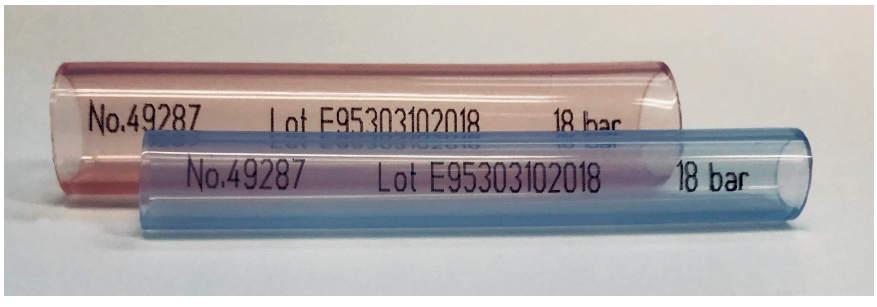

Fig. 1. Fietz Polychromos has developed a special masterbatch to obtain uniform coloring and an easily readable type face on translucent components (© Fietz Polychromos)

Laser Marking of Translucent Bodies

One practical example clearly illustrates the difficulties that are encountered with translucent components. For one of their customers, Fietz Polychromos was asked to color semitransparent tubes suitable for contact with foodstuffs, and subsequently inscribe them by means of laser marking. This presented two challenges for product design: semitransparent coloring does not permit any influences on the color shade from other additives, and only a very small amount of colorant is required to obtain the semi-transparent effect. Nonetheless, this small amount must still contain the correct percentage of additives that are carbonizable with the laser printer and ensures their optimum distribution. What is more, due to the low concentration of color pigments there is a risk that possible agglomerates become clearly visible.

Therefore, Fietz Polychromos created a masterbatch specifically for this case. The masterbatch was charged with a small quantity of color pigments and a certain amount of Laserwrite additives. Thanks to the selection of a suitable pigment/additive combination, all influences on color shade were excluded, and simultaneously, laser printability was ensured.

In the first step, a blue and a red setting were tested on the customer's premises – based respectively on polyfluoroethylene propylene (FEP) and on perfluoroalkoxy (PFA) (**Fig. 1**). With the standard settings on an Nd:YAG (neodymium-doped yttrium aluminum garnet) laser, already the first printing results were successful. The inscription was sharp and high-contrast. Only the slight color increase at the crossing points of the letters will have to be improved via the laser printer parameters in order to enhance the overall result. Conversely, the functionality of the additives was optimally matched from the start.

Carbonization Down into the Depths of the Materials

A more detailed analysis of the inscription then showed a surprising result. First, it was noticed that the slight surface changes, which usually occur with laser printing, were not found on the components, or only very slightly. Consequently, there was no or practically no structural damage. Subsequently, during the in-depth optical analysis of the surface, it was observed that carbonization had only occurred very punctiform. Under 200-fold magnification, small black dots can be seen, which together determine the type face (**Fig. 2**).

For further analysis, parts of the inscription were examined in cross-section (**Fig. 3**). Hereby, it could be clearly seen that carbonization had occurred not on the surface, but at a depth. The low pigmentation leads to high translucency. Therefore, the laser light acts down into the tube wall's inner regions. Consequently, energy input is not limited to the surface, but is distributed throughout »

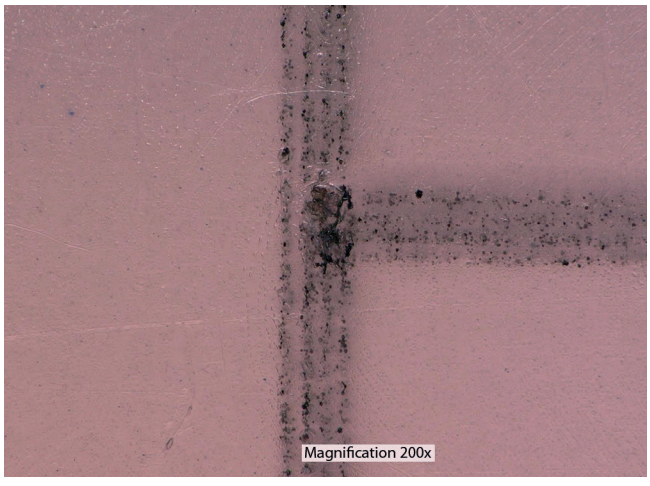

Fig. 2. Under 200-fold magnification, the individual dots forming the type face are easily recognizable (© Fietz Polychromos)

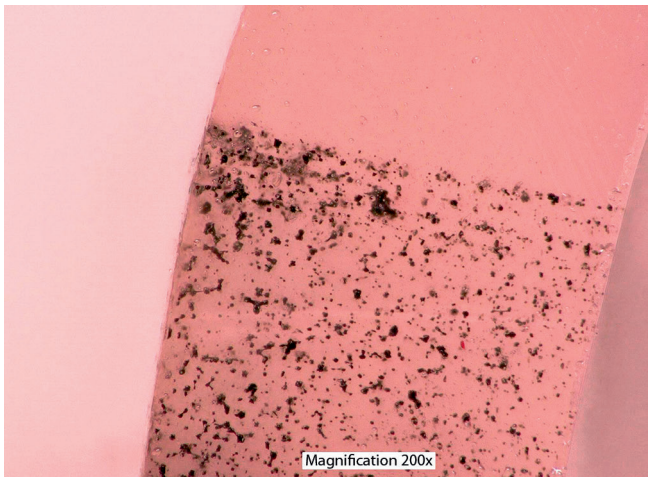

Fig. 3. High magnification of the cross-section (200x): carbonization of the additives not only occurs on the surface, but also deep into the component (© Fietz Polychromos)

the cross-section. There are no surface modifications or even degradation of the material. Only the light-sensitive additive reacts to the energy input and changes its color from transparent to black.

This eliminates one of the main previous criticisms of laser marking – structural changes in the matrix material. As a result, products can now be marked unalterably and lastingly, without impairing their properties. Marking by means of Laserwrite is highly resistant to external influences such as wiping effects, solvents or UV radiation. Therefore, the product's inscription or marking can be identified during its entire life.

Laser Marking of Opaque Bodies

Conversely, a different additive combination must be used for laser marking of through-colored fluoro plastics. In this case, energy input occurs exclusively on the surface. The light energy is absorbed and transformed into heat energy. This causes a structural change of the matrix material. This is illustrated clearly by two examples – a white inscription on a gray background and a black inscription on a yellow background.

Both products had an entirely different focus. The purpose of the white marking was to ensure a clearly visible and durable inscription on a protective tube on an automobile's underbody. The inscription must remain perfectly legible, also after long-term exposure to very

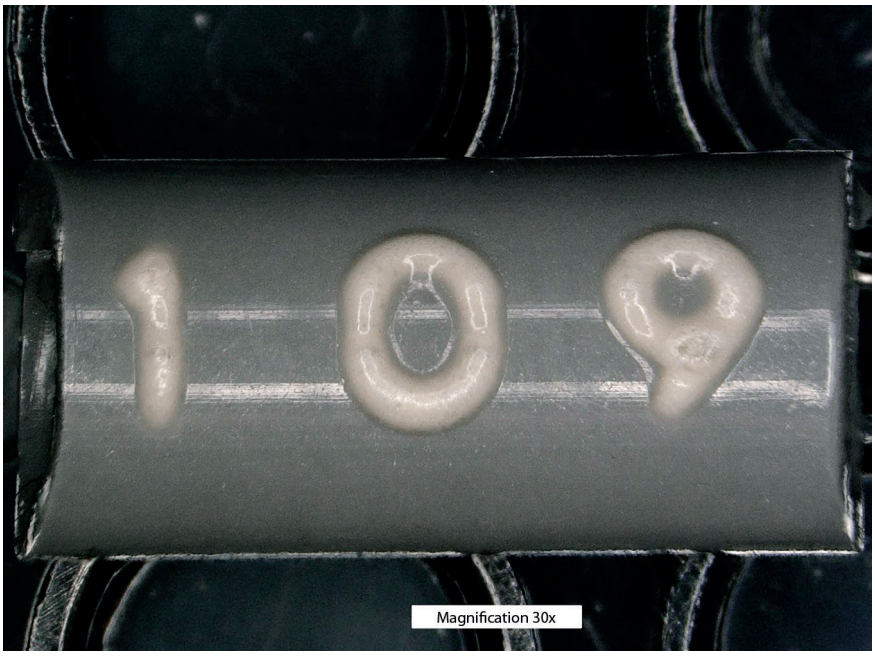

Fig. 4. The formation of white foam ensures a good contrast on the dark background, but also causes a significant modification of the component's surface (© Fietz Polychromos)

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Company Profile

Polychromos GmbH was taken over by the Fietz Group, Burscheid, Germany, at the start of 2015. Amongst other products, the resulting company **Fietz Polychromos, GmbH**, Burscheid, supplies liquid colorants for PTFE emulsion as well as color concentrates and compounds for fluoro plastics plus other high-performance polymers. Further company mainstays are processing and recycling of fluoro plastics.

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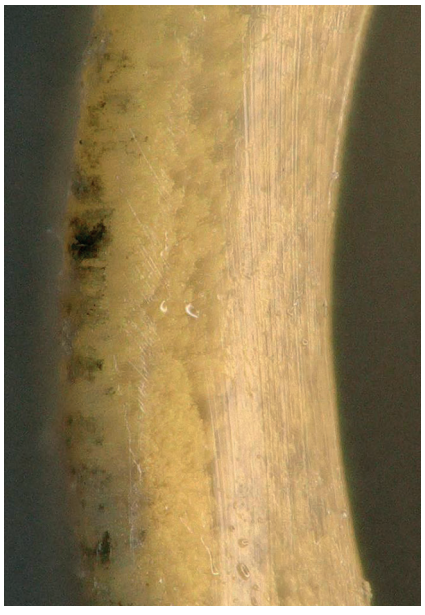

Fig. 5. The use of additives enables foam formation to be prevented almost completely. In this case, carbonization only occurred on the surface (© Fietz Polychromos)

harsh environmental conditions. As the component's outer fluoro plastic layer only provides protection against corrosion, liquids, and temperature, changes to the matrix surface are not a problem. The decisive properties for this application are not changed. A clear structural change due to the white foam formation is shown in the cross-section. The selection of this very pronounced surface modification was based on the conditions described above to obtain the highest possible contrast and maximum font weight (**Fig. 4**).

In the second example, the Laserwrite technology was used to mark a yellow component with a black inscription. Because of the requirements placed on the component's wall thickness in this case, the aim was to reduce the structural changes to a minimum. The cross-section shows clearly that the onset of carbonization is only very slight on the outer surface (**Fig. 5**). Foam formation in the material has been suppressed almost completely. As a result, the component's wall thickness is practically not affected.

With the help of suitable additives it is possible to apply durable and clearly legible inscriptions by means of laser printing – without negative influences on the plastic's properties. However, such high quality can only be achieved by matching the additive and the color with direct reference to the application. ■

Laser Marking

Different methods exist for the inscription of plastics by means of a laser. During discoloration, the laser's energy creates a color change in the plastic. Widely known is e.g. the carbonization of polymers, whereby soot particles are formed, thereby producing a black type face. During foaming, the laser melts the plastic, and tiny gas bubbles are formed. Due to the bubbles, plastic foam is generated at the treated location. This method is frequently used with dark-colored plastics. Furthermore, the laser beam enables polymers or parts of a previously applied varnish layer to be removed, thereby creating an inscription. Another possibility is the use of additives, which are discolored by bombardment with the laser.