Press Release 'K 2004'

BASF, TREFFERT and ROFIN present new laser additives for welding polymers in any color combination:

Laser Polymer Welding - No Limits for Colors

LUDWIGSHAFEN / BINGEN / STARNBERG **– Laser welding of polymers has established itself as a promising and mature industrial joining technology during the last few years. In medium-term forecasts, market experts believe, that approximately 10 % of all welding systems will be equipped with laser technology. The majority of applications are currently found in the automotive industry processing dark colored polymers. Up to now, the results of light-colored or transparent polymer welding have required significant improvement.**
At the 'K' exhibition (20. - 27. October in Düsseldorf), BASF, TREFFERT and ROFIN will present a new class of laser additives: the Lumogen® IR product line with which any colored polymer can be welded. Another technical highlight is the welding of optically transparent and fluorescent colored polymers.
This opens up new possibilities of innovative and high-quality joining applications, particularly in the medical device and electronics industries and in the field of design.

No more limits for coloration

Laser welding of polymers is achieved by overlap welding: the laser penetrates the upper polymer layer and is absorbed by the lower.

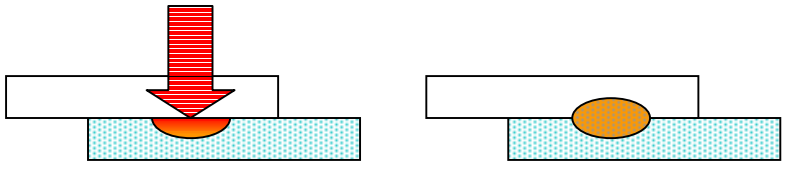

Fig. 1:
Concept of overlap welding:

The laser beam penetrates the upper layer and is absorbed by the lower. The generated heat is transferred by heat conduction.

The mutual melt pool achieves almost base material strength after solidification.

Heating and melting of the upper and lower material inside the component is a contact-free process. Laser joints can almost reach mechanical strength of the base material making them stronger than conventional joints. This motion- and contact-free overlap welding process simplifies constructions and produces welds without generating any micro particles on the component's surface. Welding seams can even be applied close to sensitive electronic components, micro mechanical parts or vibration-sensitive membranes.
These benefits are the reason why more and more components in the automotive, electronics and medical device industries are laser welded. However, the coloring range of components has been very limited up to now.
The extent to which the laser radiation is absorbed, is usually determined by embedded absorbing additives such as pigments or dyes and not by the polymer matrix itself.
As such absorbing additives usually have a intrinsic color of their own in the visible range (e.g. a perfect deep black with carbon black) a compromise had to be found between technical design and the demands of the marketing department with regard to coloring.

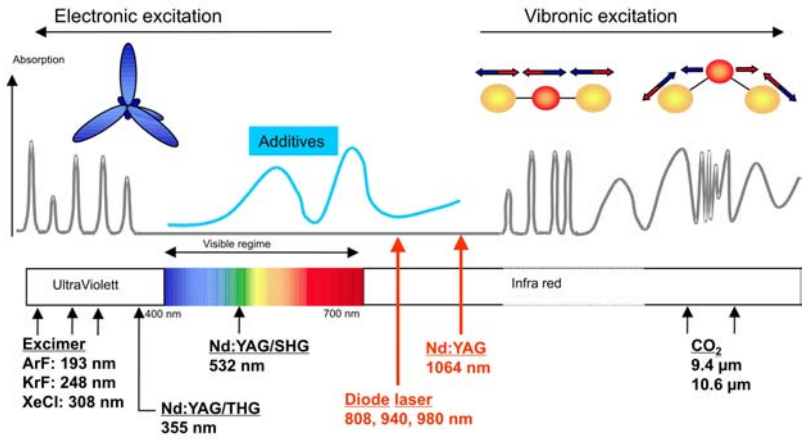

Fig. 2:
Most polymers (grey graph) absorb light in the UV and IR range. In the visible and near IR range they are transparent or show a milky white translucent behavior. In order to adjust the absorption performance for laser welding appropriately, absorbing systems have to be embedded into the polymer matrix.

The ideal laser additive, however, would exhibit high absorptivity at common laser wavelengths in the NIR range, no absorption in the visible range (i.e. no residual color) and no optical scattering. Furthermore it should not affect the mechanical characteristics of the polymer matrix, it would be non-

toxic and could be processed even at high die casting temperatures. This is why Lumogen additives are of interest.

Lumogen® IR - highest flexibility for laser transmission welding of polymers.

BASF's new Lumogen® IR product line - a result of a long term interdisciplinary research and development effort in the field of functional additives and colorants - will be officially launched at the 'K' exhibition in Düsseldorf. The Lumogen® IR line consists of highly efficient organic NIR absorbers based on proven BASF colorant technology.
The first two products of this innovative generation of additives, Lumogen® IR 765 and Lumogen® IR 788 exhibit thermo- and photo stability at levels hitherto reserved exclusively to inorganic materials, coupled with a processability typical for a classical organic polymer additives.
A structural similarity to graphite is evident in the distinctive chemical resistance and the low reactivity of this class of cmpounds. In contrast to graphite, however, Lumogen® IR 765 and Lumogen® IR 788, however, exhibit good to excellent solubilities in all common transparent and translucent thermoplastic polymers. Another highlight is their high NIR absorption efficiency together with only a slight, easy to compensate residual color in the visible range.

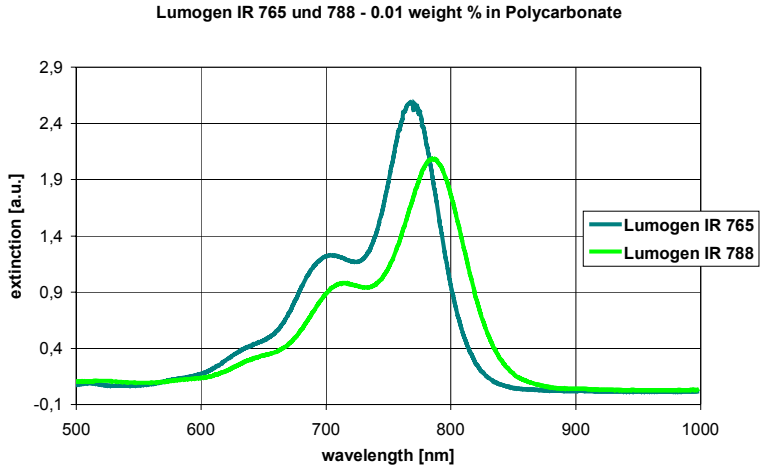

Fig. 3:
VIS/NIR-absorption spectra of 3 mm polycarbonate sheets, additivated with 100 ppm of Lumogen® IR 765 and Lumogen® IR 788, respectively.

Lumogen® IR 765 and Lumogen® IR 788 are nonionic, free of halogens and heavy metals and non-toxic making them ideally suited for the medical device technology and other sensitive applications.

Masterbatch: From additive to laser optimized polymer

The production of laser-suitable polymers with optimized coloring usually requires a masterbatch producer.
Since the mid-nineties, pioneering work has been done at TREFFERT Polymer-Technologie on specific masterbatches (or compounds) for laser transmission welding of thermoplastics. TREFFERT was one of the first to develop industrially used laser-transparent black solutions for the automotive sector.
Today, the range of products comprises a large number of laser-transparent color combinations which fulfil other demands such as migration and heat stability, light and weather fastness.
The last great challenge, the production of laser-absorbing transparent or light-colored polymers, which are primarily used in medical device technology or in high tech products, is now possible with the new Lumogen® IR additives.
Many years of experience of TREFFERT Polymer-Technologie in necessary loading levels and application forms of NIR absorbers for laser transmission welding of two overlapping polymer materials has lead to the development of Lumogen® IR 765 and Lumogen® IR 788 in cooperation with BASF and ROFIN.
Lumogen® IR 765 and Lumogen® IR 788, used as absorbers for laser transmission welding, have been successfully tested for a wide range of polymers. The resin spectrum ranges from the standard polymers like polyolefines and polystyrene to engineering plastics like polyamides, ABS or polyester. The high absorption efficiency and the excellent thermal stability of these organic NIR absorbers even allow for their use in high-quality polymers with a high melting point, such as polysulfone (PSU), polyetherimide (PEI) or polyetheretherketone (PEEK).

The low residual color and the high transparency of these NIR additives enable the creation of nearly every desired transparent color shade. Almost all non-transparent or opaque colors can be reproduced - from intense colors to a white similar to RAL 9003. Lumogen® IR 765 and Lumogen® 788 show very excellent dispersion in all types of polymers. Compared to carbon black, the distribution in the laser-absorbing part is much more homogenous, resulting in a much more constant absorption along the welding path which guarantees a high process reliability in transmission welding.

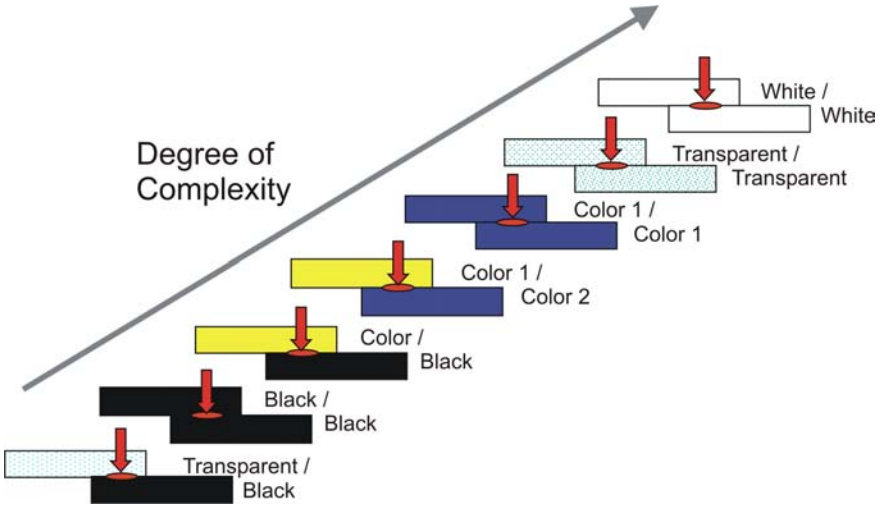

Fig. 4:
Increasing degree of complexity in overlap welding of polymers. Laser light penetrates the upper layer and is absorbed by the lower material. Combinations with a high degree of complexity are realized with special laser additives.

Lumogen® IR 765 and Lumogen® 788 are highly efficient additives. Very low concentrations are required due to their optimal physical and optical characteristics, yet they can be easily mixed into polymers either as masterbatches or as compounds.

TREFFERT develops and supplies almost all colors as customer-specific masterbatches or compounds with laser-absorbing (HAT-MAB LA) or laser-transparent (HAT-MAB LT) characteristics.

TREFFERT has two ROFIN PolyScan laser systems in their laboratories, one with Nd:YAG laser - 1064 nm, and one with diode laser - 808 nm.

Lasers for welding with Lumogen® IR

Due to their specific absorbing characteristics, polymers with Lumogen® IR are welded with diode lasers with a wavelength of 808 nm.
Extremely high extinction coefficients of Lumogen® IR absorbers allow welding with a laser power between 30 and 150 Watts for the majority of applications.
As Lumogen® IR additives do not disintegrate during heating, several laser passes over the welding path are possible. This is extremely important for crossing-points in the welding path and quasi simultaneous welding applications.
In comparison to other special laser absorbers, Lumogen® IR show high specific heat generation. This means that even polymers with high melting points such as transparent polysulfones can be welded. Moreover, the processing window is comparatively large, i. e. the danger of burned spots, bubbles or insufficient weld thickness, which are much more visible in transparent polymers is considerably reduced.
The laser producer ROFIN offers integratable diode lasers and complete laser systems for welding polymers with Lumogen® IR additives.

StarWeld® Diode

StarWeld® Diode is specifically designed for plastic welding demands.
The diode modules (optionally 75 or 140 Watts, 808 or 940 nm) are integrated in the 19" power supply unit. An optical fiber cable delivers the laser radiation to the processing head, also homogenizing the beam.
Depending on the workpiece, fixed optics or scanner deflection heads can be used. Rule of thumb is, round parts are preferably welded with fiber-coupled lasers with fixed optics whereas flat parts are welded with scanner deflection heads.
The scanner deflection heads are programmed with a user-friendly and very flexible LaserCAD editor with DXF importing function.
A number of standard industrial interfaces (e.g. profibus, network connection, serial or parallel ports), and also flexible customer interface solutions, provide easy laser integration into existing production lines and by handshake avoid wasting idle process times by the control unit.
The diode modules are produced by Dilas, one of the technology leaders and member of the ROFIN Group.
Two beam-switching modes (power supply or external shutter) allow welding of complex interrupted seams while at the same time maximizing the lifetime of the diode lasers.

The laser has external air-cooling. Essential components such as power supply, cooling and control unit etc., originate from the ROFIN platform technology with thousands of similar systems installed.
A number of additional modules and options make the lasers most flexible: integrated pilot laser or camera viewing system for application adjustments, pyrometer or setting gap measurement for process control and integrated power control.

Fig. 5:
StarWeld® Diode is specifically designed for the demands of plastic welding. Optionally the system can be supplied with direct beam, fiber coupling or scanner head.

PolyScan

PolyScan is an ergonomic complete system for polymer welding using scanner deflection heads.
The system can be provided with a diode laser of the Starweld® Diode series (808 or 940 nm) or a Nd:YAG laser of the StarWeld®-YAG series (1064 nm) with all components integrated in the compact housing.
The laser is operated via keyboard and integrated LCD monitor. The LaserCAD program allows flexible and fast programming of the welding path, either for contour or quasi simultaneous welding. Adjustment of the laser head and therefore the laser spot size can be set using the motor driven z-axis. This makes the system very flexible with regard to changes in materials or welded parts being welded.
PolyScan is the ideal laser for welding plastic parts in the development phase, for prototypes or in small volume production.

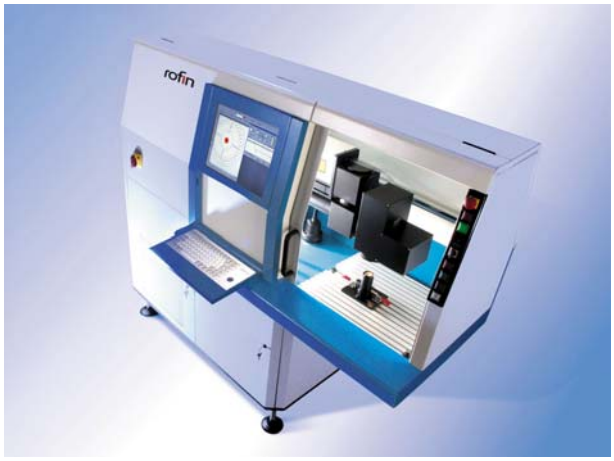

Fig. 6:
PolyScan is a turnkey laser system for polymer welding using the contour or quasi simultaneous welding method. All essential components such as the laser, control unit and power supply are integrated in the ergonomically optimized housing and are easily accessible.

Applications

Fig. 7:
Laser weld of two optically transparent plates resp. two two identically colored plates (lying underneath)

Laser weld of fluorescent plates (lower plate with Lumogen® IR)

The Lumogen® IR dyes have been tested in a large number of laser welding applications with great success.
Typical examples can be found, among others, in the medical device, electronics and sensor industries as well as in house-hold appliances and in the human care sector. Small welding paths with widths between 0,5 and 2 mm can be realized achieving extremely strong and reproducible weld seams.

Fig. 8:
Lumogen® IR dyes allow polymer laser welding of the complete color range.

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'K'-Exhibition:	**Oktober, 20.- 27. 2004, Düsseldorf**
BASF, TREFFERT:	**Hall 5, B21**
ROFIN:	**Hall 4, D45**

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