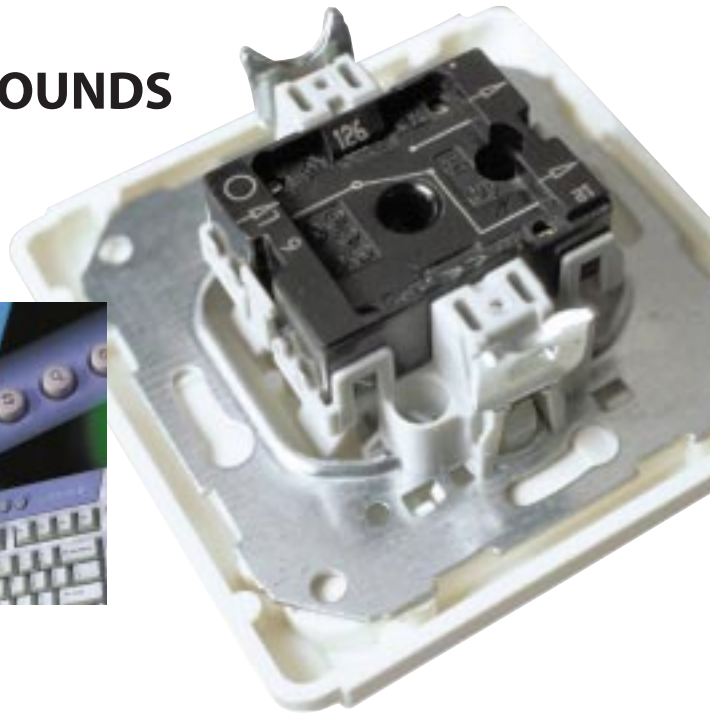
degussa.

High Performance Polymers

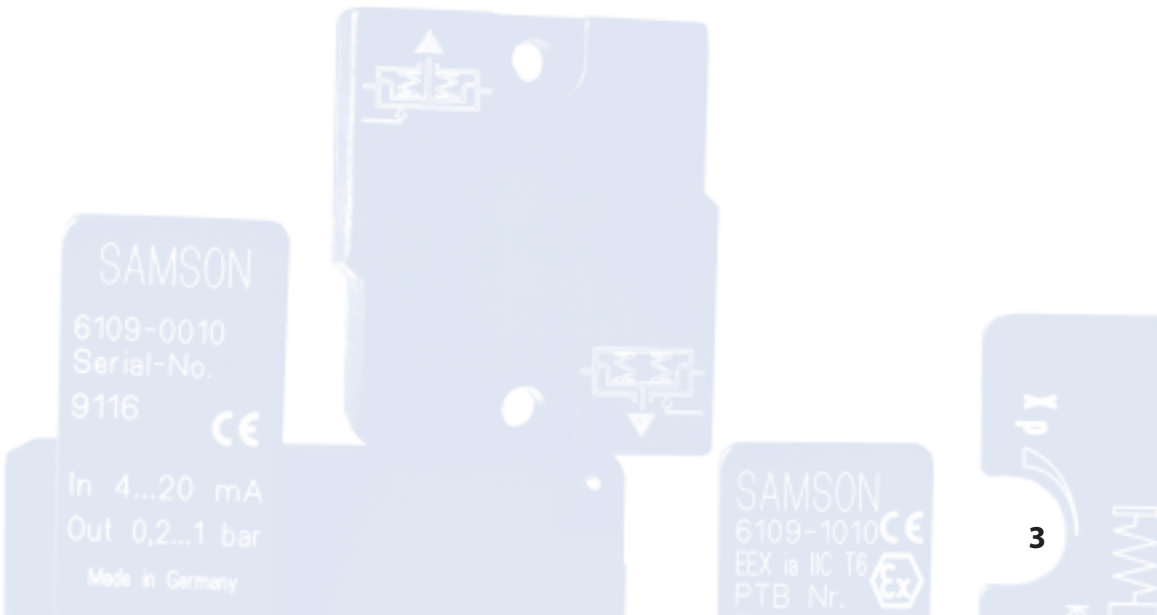
LASER-MARKABLE THERMOPLASTIC COMPOUNDS



Content

Product overview

VESTAMID® L-series (PA 12) VESTAMID® D-series (PA 612) VESTAMID® E-series (PEBA)	Polyamide 12 Polyamide 612 Polyamide elastomers
TROGAMID®	Special transparent polyamides
VESTODUR® (PBT)	Polybutylene terephthalate
VESTORAN® (PPE)	Polyphenylene ether
DYFLOR® (PVDF)	Polyvinylidene fluoride
K&K-composites	Plastic / rubber (K&K) composite systems without adhesion promotor



Introduction

The range of potential applications for laser systems in the marking of plastics has no limits. The laser marking technology is fast, flexible and precise, and more economical than the conventional printing and injection molding processes. In addition, laser marking has an important technical advantage because it guarantees durable, clearly defined, sharp contours.

The letter „E" on the computer keyboard is an indicator of this quality. It is a statistical fact that in various major languages the middle finger of the left hand strikes this letter more often than any other on the keyboard. Even after being pressed several hundred thousand times, the key should still have a high contrast value. The test requirements are specified by the German Employers´ Liability Insurance Association for Administration Workers. Abrasion resistance of the marking is important—this includes the resistance to cleaners and cosmetics.

When products are marked with a barcode, the sharpness of the contours is a further factor which has to be taken into consideration in addition to the aspect of contrast. Only when the barcode is clearly discernible from the material surface can it be correctly read and further processed by the scanner.

However, the contrast and sharpness of the laser-marked contours are dependent on the material properties of the plastics employed and their compatibility with the different laser systems. Not all the common thermoplastics absorb the laser beams equally well; this can reduce or even hinder the contrast.

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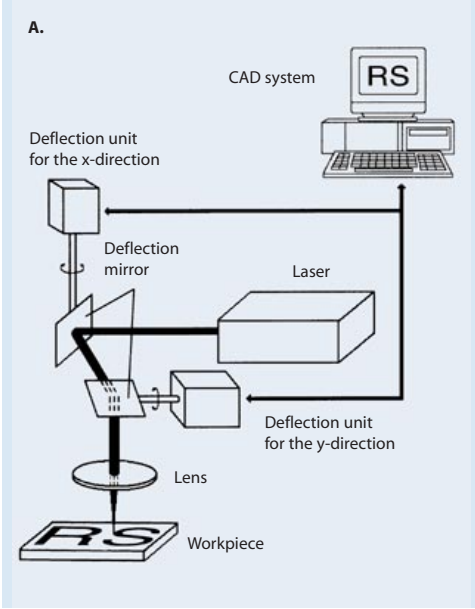
Since the Nd:YAG laser (1064 nm) is the most widely used laser, most compounds for laser marking are nowadays formulated for the wavelength of this laser. Exceptionally good contrast is achieved if the materials incorporate a special additive developed and patented by Degussa AG.

This additive ensures a dark image of the highest quality on almost all light-colored plastic formulations—irrespective of the pigmenting of the plastic, and even in cases of in-house coloring by customers. In addition, the High Performance Polymers business unit of Degussa AG also offers various dark or black pigmented products that can be laser-marked to result in light-on-dark images with good contrast.

Before choosing a suitable laser-markable material, one must know all requirements for the part to be marked. The laser-markable compounds from our High Performance Polymers product range summarized in the tables on the following pages will help you to make a preliminary selection of the suitable material.
We recommend that you consult us, your professional partner, right at the inception of a new project. Our Technical Marketing department has the know-how to select the optimum compound for your purposes and to demonstrate quick and efficient processing possibilities with these materials.

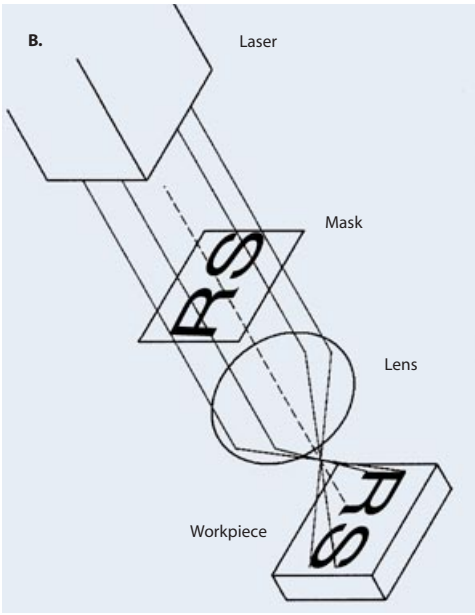
Together we can develop the innovative solution for your particular application!

Laser technology



Writing laser

The writing laser offers flexibility. The laser beam is deflected by two computer-controlled galvanometer mirrors in the x- and y-directions and focused on the part to be marked by means of a lens. An area of approx. 10 cm x 10 cm can be marked at any desired point. This laser allows every component produced in a production line to be provided with an individual marking (e.g., serial number).

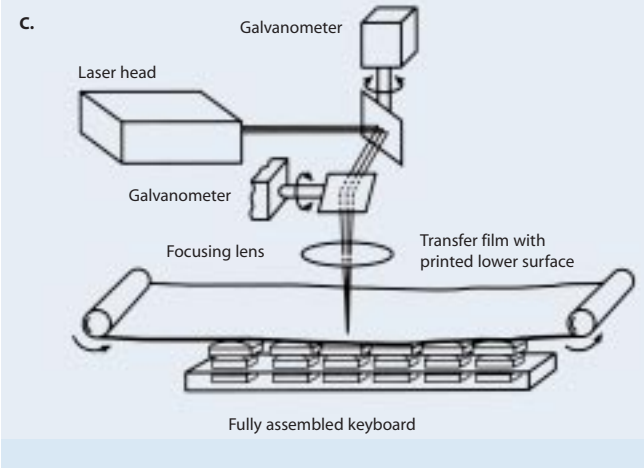


Mask pulse laser

The mask pulse laser is substantially faster than the writing laser, though not as flexible. The laser beam, which measures several square centimeters, passes through a lens and reproduces a mask onto the component to be marked. This method permits up to 200 markings per second.

Laser transfer printer

This process is a combination of thermal diffusion printing and laser marking. The development is ready to go into production, so that, e.g., function keys of computer keyboards can be marked with different colors.



Laser systems for marking finished moldings

Figures from top to bottom:
A. Writing laser
B. Mask pulse laser
C. Laser transfer printer

Benefits of laser marking

SEM image
of a line structure

■ **fast**
Marking speeds of up to 2000 mm/sec or 200 characters/sec are possible.

■ **flexible**
The layouts can be created and stored using standard CAD programs, and can then be called up in any order for fast changes.

■ **precise**
Even the smallest characters or symbols with very small line thickness can be positioned exactly and are clearly legible.

■ **clean**
No additional materials, in particular solvents, are required.

■ **contact-free**
The marking can be applied not only to surfaces which are smooth, irregular, textured or to which access is difficult, but also through transparent covers.

■ **abrasion-resistant**
Penetration depths of up to 200 µm are possible so that the marking is both wear-resistant and forgery-proof. This aspect is particularly important with respect to product liability considerations.

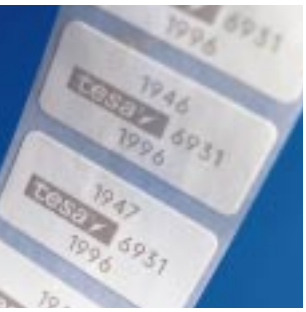
■ **resistant to chemicals**
The marking is resistant to cleaners, cosmetics or perspiration.

■ **pre-treatment-free**
Since there are no adhesion problems, the surfaces can be marked directly without any special pre-treatment.

■ **low operating costs**
The process is very economical particularly where large quantities of products are to be marked. No additional materials are required, no cleaning and disposal costs for inks, paints or chemicals, no personnel costs due to integration into automatic production processes and no storage of stamps, masks, etc.

■ **quality**
The process is characterized by a high reproducibility.

Applications



Function markings

- Computer keyboards
  very good legibility;
  frequent pressing demands
  high abrasion resistance

- Barcodes on housing components / electric switches, etc.
  • one-dimensional barcode
  • two-dimensional data matrix code
  Contrast and sharp contours are important for the reliable transmission of the coded information!

Information markings

- Name and address of manufacturer / owner, etc.
- Equipment type; product data
- Operating, setting, connection, safety or installation instructions, test symbols
- Type of voltage supply / power rating of electrical and electronic components or appliances
- Circuit diagrams / scales / technical labels

Decorations

- Company logo
- Colored symbols and patterns
  with transfer film; sometimes directly applicable

Definition and contrast of markings

Figure left:
Contrast without additive
Figure right:
Contrast with additive

The depth of staining and height of foaming can be determined from light micrographs taken of thin sections (see figure below). The staining depth should be at least 100 µm [a], and the foaming height should be as small as possible. The most significant characterization parameter of the marking obtained is legibility, which can be quantified by means of the contrast. This is determined using a luminous densitometer. In order to eliminate gloss angle effects, the measuring point is illuminated using an Ulbricht sphere-type photometer with a luminous intensity of 200 lux. The luminous densities of the background (LDB) and the characters (LDC) are determined. The contrast C is calculated as the ratio C = LDB/LDC. According to the testing principles, e.g., of the Employers' Liability Insurance Association for Administration Workers in Germany, GS-VW-SG7, the characters on key caps must have a value C ≥ 3.

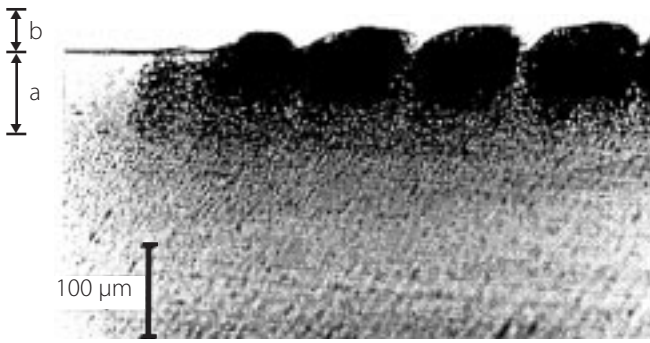


Figure top:
Characterization of the laser marking by evaluation of depth of staining (a) and height of foaming (b).

Additives

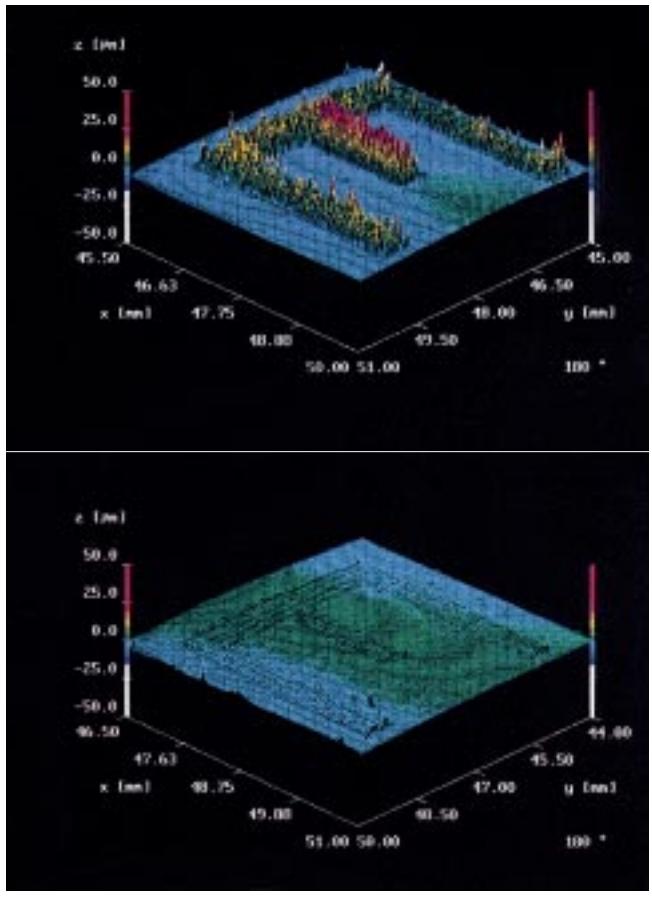
Effect of the additive

In addition to high contrast, adequate staining depth and maximum surface smoothness are required. Although the intensity of the color change reaction increases with the concentration of laser-sensitive pigment, the penetration depth of the laser radiation decreases at the same time. With a low pigment content the penetration depth is very high, but the contrast may be too low.

- The contrast increases with increasing laser intensity.
- The staining depth decreases with increasing laser intensity.
- The height of foaming (the measure of surface quality) increases with increasing laser intensity, whereas a smooth surface is desired.

With the same marking quality, the surface does not foam as much when using the additive and is therefore more abrasion-resistant.

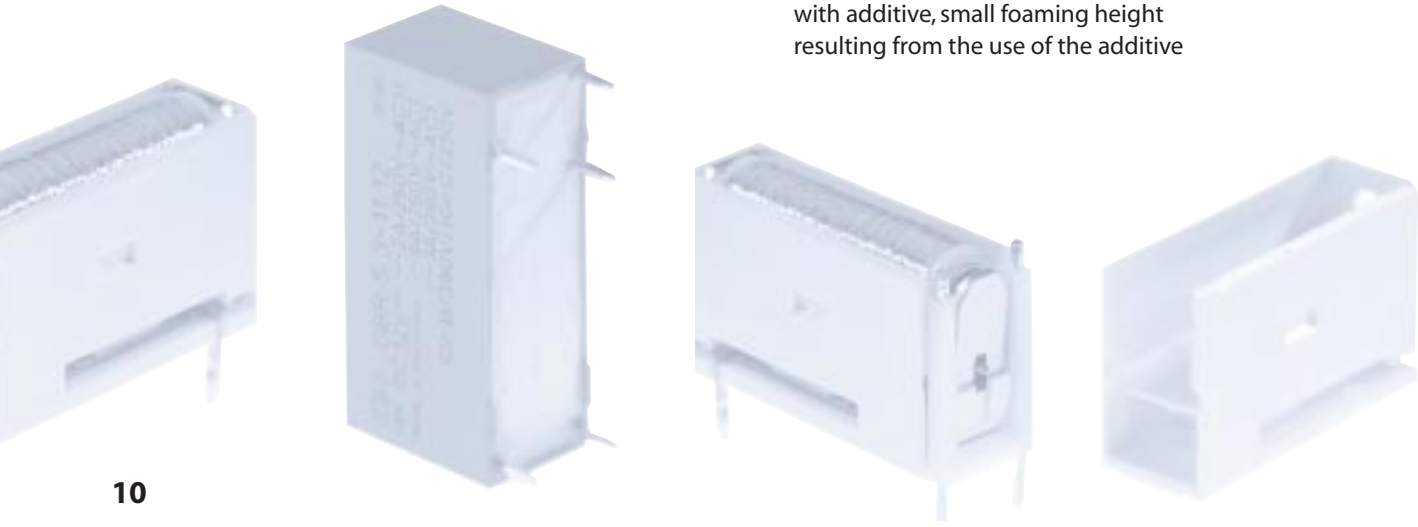
In order to guarantee excellent marking and in consideration to these effects, we have developed a laser additive which does not influence the coloring.



Surface profile of the letter „E“
with the same laser energy

Figure top:
without additive, large foaming height

Figure bottom:
with additive, small foaming height
resulting from the use of the additive



Requirements for laser-markable compounds

- High contrast value of the marking
- Good sharpness of contour of the marked image
- Low foaming height
- Abrasion resistance (also of the image)
- Recyclability
- Constant in use properties
- Resistance to chemicals
- Good flowability
- High marking speed
- Perfect surface image
- Good color stability
- Light stability

Laser-markable compounds I

VESTODUR® (PBT)

Compound	Color	GF %	Mod MPA	HDT B °C	UL94 mm, V	IMP-23°C ISO 180/1C kJ/m²	**C**ontrast Image [2] **L**ight/**D**ark	Remarks
X7061	natural white electric grey yellow green red	0	2700	160	0.8 (HB)	95	C 3.3 **D** C 4.5 **D** C 3.2 **D** C 3.6 **D** C 2.5 **D** C 2.0 **D**	PBT-LV
1003-FR3	natural white	0	3100	185	0.8 (V0)	25	C 2.8 **D** C 3.5 **D**	PBT-FR-LV
2002-FR3	natural	0	3100	180	0.8 (V0)	50	C 3.2 **D**	PBT-FR-MV
X7384	electric grey	0	2000		0.8 (V2)	55	C≥3.0 **D**	PBT-FR-MV halogen-free
X7062	black	0	2600	150	0.8 (HB)	170	C 8.5 **L**	PBT-MV
GF12-FR3	natural white	12	6000	223	0.8 (V0)	30	C 3.2 **D** C 3.5 **D**	PBT-GF12-FR-MV
G20-FR3	natural white	20	8000	223	0.8 (V0)	35	C 3.2 **D** C 3.5 **D**	PBT-GF20-FR-MV
RS1203	black	20	7500	220	1.6 (HB)	60	C 8.0 **L**	PBT-GF20-MV low shrinkage
X7095	black	20	7000	220	1.6 (HB)	30	C 8.0 **L**	PBT-GF20-MV low warpage
GF30	black	30	9500	220	0.8 (HB)	60	C 3.9 **L**	PBT-GF30-MV
X4877	black	30	5200	195	1.6 (HB)	70	C 8.0 **L**	PBT-GF30-MV-HI
GF30-FR3	natural white	30	11000	223	0.8 (V0)	40	C 3.2 **D** C 3.5 **D**	PBT-GF30-FR-MV
X9402	black	30	9000	210	1.6 (HB)	60	C 10 **L**	PBT-GF30-MV low shrinkage
X7212	natural white	45	15500	225	0.8 (V0)	30	C 3.0 **D** C 3.3 **D**	PBT-GF45-FR-MV
X9405 [1]	black	30	9000	210	0.8 (V0)	80	C 10 **L**	PBT-GF30-FR-LV-HI

[1] = Product with relatively high tracking resistance
[2] = Produced by Nd:YAG laser (1064 nm)

In addition to the above-mentioned Compounds I and II, other compositions, e.g., compounds of the VESTAMID E-Series (PEBA), are available with laser-markable properties.

Laser-markable compounds II

TROGAMID®

Compound	Color	GF %	Mod MPA	HDT B °C	UL94 mm, V	IMP-23°C ISO 180/1C kJ/m²	Contrast Image [2] Light/Dark	Remarks
T5000	black	0	2800	140	0.8 (V2)	no break	C 23 **L**	PA 6-3-T, MV
TX7389	black	0	2700	135	0.8 (V2)	no break	C 23 **L**	PA 6-3-T, LV
CX7323 [3]	transparent	0	1400	122	(HB)	no break	**D**	PA PACM 12

VESTAMID® (PA 12)

L2123	black	0	350	80	1.6 (HB)	no break	C 7.2 **L**	PA 12-w, HV, HI
L2124	black	0	380	90	1.6 (HB)	no break	C 9.5 **L**	PA 12-w, HV
L2140	black	0	1450	110	1.6 (HB)	no break	C 9.7 **L**	PA 12, HV
L-GF30	black	30	6500	175	1.6 (HB)	70	C 10 **L**	PA 12-GF30, MV
L1670	orange	0	1400	120	1.6 (HB)	no break	C 3.4 **D**	PA 12, LV

VESTORAN® (PPE)

1900	natural black	0	2000	190	1.6 (HB)	140	C 2.1 **D** C 2.2 **L**	PPE
1900-GF20	natural black	20	5600	191	1.6 (HB)	30	C 2.9 **D** C 1.5 **L**	PPE-GF20
X7342	beige	20	5700	170	1.6 (HB)	33	C 4.0 **D**	

Explanations:

[2] = Produced by Nd:YAG laser (1064 nm)
[3] = Development product upon request

GF	=	Glass fiber reinforced
Mod	=	Tensile modulus
HDT	=	Heat deflection temperature
UL94	=	Flammability class
IMP	=	Impact strength, IZOD
C	=	Contrast, depending on the luminous density of the pigment (see Testing Principles of the Employers' Liability Insurance Association for Administration Workers, GS-VW-SG7, edition 11/88)
LV	=	Low viscosity
MV	=	Medium viscosity
HV	=	High viscosity
FR	=	Contains flame retardant
HI	=	High impact

Environmental aspects and quality

Emissions

In industrial laser systems, the small amounts of gaseous decomposition products generated during the laser-marking process are drawn off effectively by means of exhaust systems.
The high efficiency achieved due to the special additives in the laser-markable compounds from Degussa's High Performance Polymers makes the process even more environmentally safe. The benefit is quite clear: If the contrast value is achieved with a low laser energy, less decomposition occurs.

Recycling

All laser-markable engineering plastics from Degussa AG described in this brochure can be easily recycled: Sprues and unmarked moldings can be returned directly to the primary process as regrind. Only recycled materials from parts already marked should be used for a secondary application due to their possible discoloration.

Quality

High Performance Polymers business unit of Degussa AG is certified in accordance with ISO 9001 and thus recognized as a reliable supplier.

Our products set a high quality standard on the market. We offer tailored solutions designed to meet specific requirements. This is true in particular because of the close tolerances in coloring.

Future prospects

Wear resistance and protection against forgery are aspects which will promote the further advance of laser marking systems. Whether for product liability or the future recycling of finished parts, quality-relevant or production-specific data etched by laser leave no doubt as to the origin of a molding. Manufacturer, production dates, machine numbers, material batches—all these parameters can easily be recorded.

Where very small part geometries are involved, the compact data matrix code (DMC) is the ideal solution; with the ongoing miniaturization of components, this system will be the data code of the future. It encodes the data in the matrix both horizontally and vertically so that thousands of items of information can be recorded on the smallest surfaces. In addition it is possible to mark data in both public and private mode which can then only be read with a corresponding access authorization.

In the USA, the DMC has already become an important instrument for the police in identifying vehicles. Every car has the data matrix code marked visibly on the windscreen and the vehicle registration data can be called up on the spot using a portable scanner.

If the technologies of laser marking and data matrix code are used on suitable materials from our product range (see Tables I and II on pages 12 and 13), product identification is possible with an extremely high degree of security which practically eliminates the risk of substitution errors.

Furthermore, the method offers potential for savings in the logistics of computer-controlled production processes. This can be clearly illustrated with the example of an automobile manufacturer who has to assemble several thousand individual parts to a single unit and uses different components, depending on the vehicle model. This is barely feasible without sophisticated logistics. In automated production lines, control functions are essential in order to guarantee the maximum safety and reliability.

Source:
TEC Elektronik GmbH

Please involve us in solving your problems. Give us a ring.
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System solutions from the planning stage ...

- Advice on materials
- Individual concepts for compounds
- Mold design (CAD, CAE)
- Support in product design and processing technology
- Analyses and tests
- Assistance in Process Control and Instrumentation Service (e.g., for quality monitoring)
- Issues concerning standardization and approvals
- Availability of material samples
- Recommendation of suitable suppliers for machines or parts
- Advice on recycling
- Safety questions
- Intensive project support through close co-operation
- Products of a consistently high quality standard (ISO 9001)
- Demonstration of the marking on our laser system in Marl

… to the production stage

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