



New printing process for personalized plastic design

# Freedom for color!



*It soon will be just as easy to print photos on plastic parts as it is on paper. Personalized mobile phone casings and strikingly realistic imitation wood are just some of the new design possibilities. Engineers from Bayer MaterialScience have developed the underlying technology.*



Photo phone: digital photo printing could soon make mobile phones individual and unmistakable. A new abrasion-proof printing technique developed by Bayer can print flowers, leaves, water, fruit (above) or even the user's ear (left) onto the plastic.

The dark-brown instrument panel – an elegant slice of knotty wood with a lively, fine grain – radiates class. It's precisely the look luxury car owners love. The exquisite piece, however, is not gracing the dash of a top-of-the-range limousine; in fact, it is lying in a test laboratory at Bayer MaterialScience. What looks like a highly polished slab of seasoned wood is made entirely of plastic. "A layperson wouldn't be able to tell there's no real wood at all in the instrument panel component," explains Hans Braun, group manager at Bayer MaterialScience.

This perfect reproduction was made possible by an ultra-high-resolution digital printing process. Armin Berger, a member of Braun's team, collaborated with several partner companies to develop a special method for printing photoquality images on plastics, which is a source of previously unimagined possibilities for giving plastic articles a unique design. The biggest hurdle was going from printing to a three-dimensional part, the engineer relates: "Everything's easy when you're printing on a flat sheet." However, during thermoforming of the film to make what is known as a "film insert", the materials encounter temperatures of up to 90 degrees Celsius and pressures equal to three hundred times atmospheric pressure. Few inks can withstand that kind of treatment without damage. The thermoformed film is then trimmed and back-injected with plastic.

In the past, screen printing was the established method for transferring colored patterns, letters or numbers onto transparent, scratch-resistant polycarbonate film. With this method, ink is applied through a fine screen onto a sheet of transparent polycarbonate film. The screen is permeable to the ink in some areas, non-permeable in others. Because a separate screen must be fabricated for each color, screen printing is most suitable for crisp, graphic designs and large production volumes. "Photoquality images are too complex to produce by the screen printing method," says Hans Braun, pointing out another disadvantage. Ever since it became possible to print digital images and photos from a computer directly onto paper without any intermediate steps, he has been dreaming about digitally printing plastic parts just as easily.

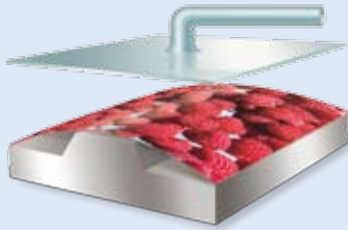
### **First of all, a digital printer for short runs**

Braun and his team identified a technology capable of doing just that at Hewlett Packard: the Indigo printing press. Right now, its main application is short-run printing of product labels and brochures. For Braun and Berger, it was important for the Indigo presses to deliver image quality comparable to that of offset systems, which produce most printed matter today, such as books, newspapers and packaging. Another advantage of Indigo is that

## From film to mobile phone housing

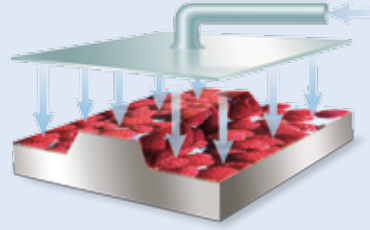
### 1. Decoration

The back of the polycarbonate film is printed by means of screen or digital printing. Polycarbonates are transparent polymers from the polyester family. CDs, and interior aircraft windows are examples of products made of polycarbonate. After printing, the polycarbonate films are placed on a mold.



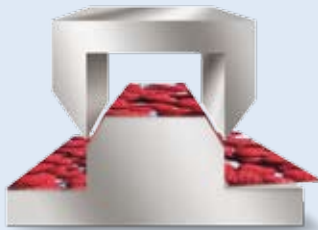
### 2. Thermoforming

The film is converted to the desired three-dimensional shape in a high-pressure forming process patented by Bayer. Letters and numbers may shift by only a fraction of a millimeter.



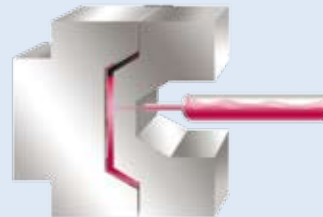
### 3. Cutting

Excess film sections are trimmed.



### 4. Backmolding

Liquid plastic, usually made of polycarbonate as well, is injected onto the back of the film and hardens in a few seconds.



unlike many other digital printing systems, it can print the color white.

### The first hurdle: will the ink stick to the film?

The first problem facing Berger and his co-workers was simply to get the ink onto the film: "The liquid inks didn't wet and adhere to the polycarbonate the way we wanted them to," says Berger, describing a universal problem. To prevent the printing inks from running on the Makrofol® polycarbonate films from Bayer MaterialScience, the films were ultimately provided with a special adhesion layer known in the trade as a primer.

Other challenges arose when it came to back-injecting the film. While it has been possible for several years in screen printing to inject the plastic directly onto the ink, the inks used in digital printing cannot withstand direct contact with plastic at 300 degrees Celsius. This problem was resolved by the conventional sandwich principle: "The ink has to be protected by a film backing," explains Berger.

But the multi-layer principle harbored difficulties of its own, because the film sandwich displayed poor inner



adhesion. The bond was weak, particularly in spots with a lot of ink. "The ink was the weakest link in the laminate. As a result, the protective film began to separate from the finished part," explains Berger.

### Sandwich structure brings success

Finally, the team made a breakthrough: a thin layer made of Desmopan® thermoplastic polyurethane from Bayer MaterialScience provides the necessary bond. "Thanks to the multi-layer structure of the film, the digital printing process is still relatively complex," says Berger, "but it now functions reliably." The knotty wood panel, manufactured with an industrial production mold, illustrates the success of the method. And other fashionable variations of the component demonstrate the versatility of digital printing: the panel gets an upbeat look with a sunflower, lettuce or even raspberry design. After all, there are no limits to personal preferences and choice!

The current film composite probably is not the last step in the development process. Braun and Berger already have digitally printed panels on their desks

that required neither a primer nor a film backing. One interesting variation that may soon be possible is inkjet printing, which works on a similar principle to the inkjet printers used in offices, albeit in a different dimension in terms of quality. Bayer MaterialScience creates tailor-made solutions to meet its customers' needs and supplies the requisite technical support. "You could say that we are advancing digital printing on our own initiative," claims Braun. After all, Bayer wants to be there when the method becomes established on the market, which Braun predicts will happen in no later than five years.

### Unique items at off-the-shelf prices

Berger knows that having a variety of designs is a popular trend, particularly for articles with a short life cycle, such as mobile phones. From development, to marketing, all the way to "free" one-euro devices, the entire life cycle of a mobile phone is no more than a year. Other potential applications include graphically designed video game consoles and exchangeable housings for MP3 players and Palm Pilots. "Thanks

to digital printing, we can deliver more sophisticated designs for a comparable price," says Braun, underlining the main advantage of the digital printing method. "Even one-of-a-kind items like mobile phone housings with holiday snaps could be produced more economically."

If that happens, things will finally start looking up for people who love fine wood finishes, but because of inadequate funds have been forced to spiff up their cars with tacky sticker sets!



[www.makrofol.com](http://www.makrofol.com)  
The Bayer MaterialScience site profiles additional printing applications.

Precision forming: the high-pressure thermoforming process prevents letters and photographic elements from shifting positions when the printed film is molded into its three-dimensional shape (left photo). The film is then punched out and back-injected with plastic to produce plastic parts with a unique design, as demonstrated by Hans Braun (left) and Armin Berger (right).



## Printing methods

In contrast to conventional screen printing, the main strengths of digital printing are its short-run economy and photo-quality reproduction.

Screen printing	Digital printing
Economical for long-run printing	Enables true personalization, economical for short-run printing
Thick ink layers and special-effect inks	High-resolution images up to photoquality
Production of printing screens	Digital data transferred to printing press, printed image transferred directly to substrate
Printing without a primer, injection molding directly onto ink	Printing with primer, protective film backing protects ink (with HP Indigo)