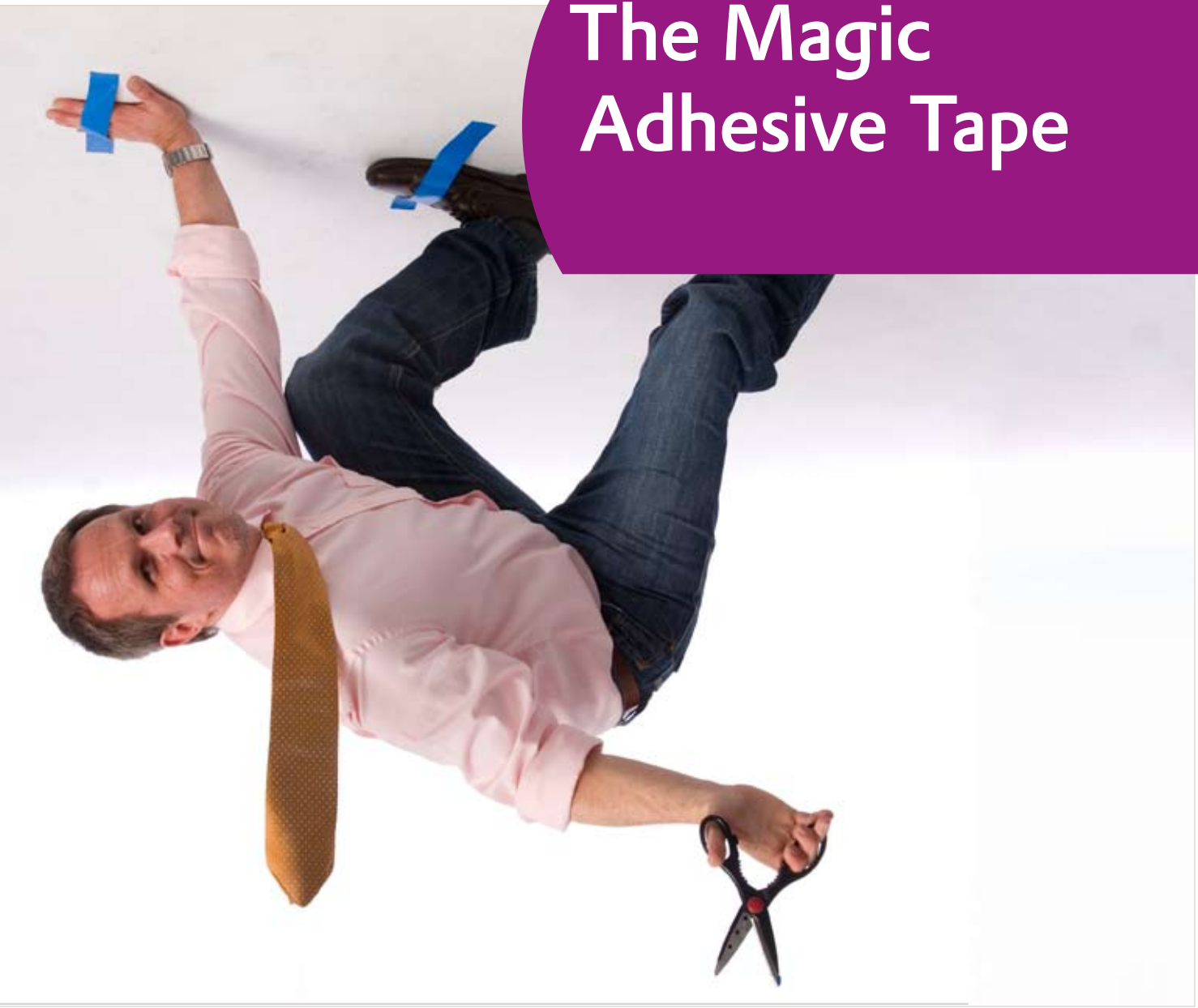
EVONIK INDUSTRIES

The Magic Adhesive Tape



In the near future, electronic devices could be much smaller, lighter, and more powerful than at present. This is feasible thanks to a novel high-tech adhesive tape system, the product of a collaboration between Lohmann GmbH und Co KG and Evonik Industries. No joke: The adhesive force is 300 percent higher. Not only can it bond, it also offers the possibility of „debonding" – so you can get back down to the floor, if needed.

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Evonik. Power to create.

The Motorola International 3200, launched on the market in 1994, weighed half a kilo and was 33 centimeters long. As the world's first cell phone, it functioned in all digital mobile networks and could send and receive SMSs. GSM (Global System for Mobile Communications) is the name of this system, now a global standard. It marked the beginning of a new cellphone generation allowing mobility throughout Europe and replacing the analog system. So ubiquitous has the cell phone become that it's now hard to find a person who doesn't use one.

Much has changed since the 1990s, with cell phones becoming increasingly smaller, lighter and more powerful. New standards of durability have also been established: If the Motorola 3200 fell from a moderate height, it would have had to be consigned to the scrapheap; today's cell phones are far sturdier.

And now, a completely new adhesive technology could once again revolutionize design and functionality. It allows the size of today's phones to be halved without difficulty, and with no loss of performance or increase in price. The possibility of cell phones worn like wristwatches is now within reach.

Forms are die-cut from the band and are used to bond together components for electronic devices.

The limits appeared to have been reached

What makes this possible is a seemingly unremarkable adhesive tape system that packs a punch. This is currently being developed in Neuwied, Germany, by Lohmann GmbH & Co KG, an internationally active specialist in double-sided adhesive tapes. This system is based on an Evonik invention: An innovative adhesive additive named MagSilica® that was developed by researchers in the Chemical Business Area together with Professor Paul Roth of the University of Duisburg. This allows parts to be bonded much more rapidly and with significantly higher adhesive tensile strength than before. The higher adhesive strength in turn allows miniaturization of the parts to be bonded; until now, these parts have had to be of a specified minimum size, partly so that the adhesive adheres to them adequately.

DuploCOLL® RCD, a new product, achieves 300 percent greater adhesion than ordinary high-performance adhesive tape.

The success of this innovation has come at a time when the limits of the adhesive bond strength were believed to have been reached. Conventional adhesive tapes could previously produce only a fraction of the adhesive strength of structural liquid adhesives. However, liquid adhesives are difficult to use with the smallest parts: high-tech, accurately die-cut adhesive tapes are far more suitable for this purpose. Such die-cut products are a specialty of the Lohmann Group. Evonik's MagSilica® therefore slotted perfectly into the research activities of the adhesive tape experts.

This novel filler, along with innovative approaches from adhesives chemistry, yielded a solution combining the two worlds of liquid and pressure-sensitive adhesives. The new adhesive system developed by Lohmann is called DuploCOLL® RCD (Rapid Curing on Demand). It looks like, and is processed in the same way as, classic pressure-sensitive adhesive tape, but a downstream curing process allows bond strengths that cannot be achieved by conventional pressure-sensitive tapes. MagSilica is used, somewhat in the role of a turbocharger, for the short cycle times that are necessary. Incorporating 5 to 15 percent of MagSilica® into the adhesive matrix drastically reduces curing time: Instead of the 5 to 30 minutes previously needed, curing is now complete in no more than 30 to 60 seconds. This is achieved by inductive hardening: Curing is performed by applying an electrical voltage so that the energy is distributed very uniformly. An almost stress-free bonded joint can thus be obtained within seconds.

DuploCOLL® RCD bonds to a wide range of surfaces like plastic, glass, and steel, and is significantly more powerful than conventional adhesive tape. "With DuploCOLL® we get about 300 percent more adhesive power than with conven-tional high-performance adhesive tape," says Dr. Hansjörg Ander, head of R&D at Lohmann. "Before the use of MagSilica® this was totally inconceivable. An increase of even 50 or 60 percent would have been regarded as an enormous success." What this means can be illustrated by the example of the loadbearing capacity of a plastic hook glued to the wall. If attached with conventional pressure-sensitive adhesives, it could withstand a load of 3–5 kilograms; this would increase to 20–40 kilograms for the new adhesive.

Bonding at the push of a button

This advance has been achieved partly through nanotechnology. Evonik researchers incorporated into conventional adhesives nanomaterials that be-have superparamagnetically. This means that these particles can be heated by alternating electromagnetic fields, giving them entirely new properties. “Bonding at the push of a button,” says Harald Herzog, manager of New Business Development for Aerosil at Evonik, “is the simplest way of describing what MagSilica® makes possible.” And in fact the curing process is initiated and ended promptly, and on demand, so to speak. An adhesive of this type is warmed in a high-frequency electromagnetic field, where it heats up extremely fast. In just a few minutes, enormous bonding strengths are achieved and long curing times are no longer necessary.

A further advantage is that heating is restricted to the area of the joint; the rest of the component is heated only moderately, if at all. “Induction hardening significantly accelerates the entire processing stage,” says Herzog, “because further processing of the component can continue immediately. The adhesive is heated and the joint cured, but the rest of the component stays cool. As a result, even heat-sensitive materials such as plastics can be bonded without being damaged.” And the process is economical, too. Because cycle times are drastically reduced, it saves considerable time and energy.

More room for new functions

Faster processing, stronger bonding, and a smaller size: that summarizes the advantages of using DuploCOLL® RCD in electronic devices.

It might be asked whether cell phones really need to be smaller; after all, most keys are already smaller than the finger tips pressing them. The answer, of course, is that they need not be. But DuploCOLL® RCD can undoubtedly be used to excellent effect for further miniaturization of devices. And that applies not only for cell phones but also in areas where reduced size is associated with improved functionality, as in portable computers, digital cameras, DVD players, stereo systems, and household gadgets, as well as hearing aids and other medical devices. Even where further miniaturization is not an absolute necessity, the new adhesive saves space. And it lends itself very well to new functionalities and designs.

Although originally conceived of as a simple telephone, the cell phone is now much more that. Internet access, music, films, electronic newspapers, and social networks are all possible, and will be even more in demand in the future. Miniaturization of the components can make a major contribution toward ensuring that the device remains functional and easy to operate.

Not confined to electronics

Another innovative field of application for the extra-strength adhesive system with MagSilica® is opening up in another sector. The automotive industry will benefit greatly from the new processes enabled by MagSilica®. Greater importance has been given to adhesion technology ever since cars have been re-quired to save more energy. Bonded joints allow the use of lighter materials such as aluminum or plastics, which cannot be joined by soldering or welding. One kilogram of adhesive used in this way reduces the weight of a car by 25 kilograms. It's immediately obvious that the use of the adhesion technology significantly reduces fuel consumption.

Until now, however, the use of adhesion technology in automotive construction has had two serious disadvantages. First, adhesives needed very long curing times. For metal-free joints, this problem is eliminated by the use of MagSilica® and inductive hardening in the high-frequency range. Second, the bonding was not easily reversed, which is a major drawback in repairs and recycling. For this too, MagSilica® offers a solution, because the adhesive additive has another magical property. It makes it possible to debond joints that have been specifically designed with this possibility in mind.

A solid bond, thanks to MagSilica®. During repairs or recycling, the bonds can be loosened easily again.

Potential for the automotive industry

The adhesive joint is debonded as quickly and easily as it is formed. This is possible with the MagSilica® nanocomposite. On selective rewarming, the nanoparticles incorporated into the adhesive can destroy the previously formed adhesive bond, allowing very easy debonding. The damage that could be caused when, for example, welding torches or lasers are used for heating is minimized here. The advantages of adhesive bonding therefore include positive properties that have until now been restricted to screw joints. Even heat-sensitive materials can be bonded using an adhesive to which MagSilica® has been added, without damaging the material.

High-performance adhesives based on MagSilica® will clearly revolutionize the joining of plastic parts in automotive construction. They open up new possibilities not only in large-scale production but also for repairs and recycling: when the car has reached the end of its useful life, the various plastic components can be separated out and recycled without great effort— which is something the automotive industry's been waiting for a long time.