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Cover photo: Schott-Rohrglas supplied 63,000 special glass tubes made from "Duran" borosilicate glass to Wedeco Environmental Technologies. The Herford company used them to manufacture electrodes for the world's largest ozone generation plant, scheduled to go on stream at VCP, a major producer of paper and cellulose in Brazil, in 2003.

Photograph: Mathias Sandmann

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Mounted on Thin

Burgeoning quantities of data and increasingly faster rates of transmission in telecommunications require electrical components whose performance must be constantly improved to meet these challenges. Greater demands are thus also being made on materials for circuit boards. The thin glass produced by Schott in Grünplan is an ideal substrate for these high-tech components of the future.

► Everything in the world of microelectronics was in perfect order until the turn of the millennium. The year 2000 saw a booming economy, full order books and production facilities working at capacity around the globe. Not even 20 months later, however, the bubble had burst; the electronics industry is now experiencing its worst crisis since the invention of the transistor. Just how this roller coaster ride will continue is unclear, but one thing is certain: in the long run, the economic and technical locomotive functions of the branch will return again one day. "A strong development of the electronic market with medium-term growth rates from six to eight percent is beyond doubt, and the market will offer us excellent opportunities for growth," stresses Michael Kowalski, Managing Director of Isola AG in Düren, the world market leader in the field of base materials for printed circuit boards.

The innovative capabilities of the industry and similar strengths of certain partners are the reasons for Kowalski's optimism. With this potential in mind, Schott Displayglas GmbH in Grünplan/Germany, PPC Electronic AG in Cham/Switzerland and Isola formed a trio to jointly explore this promising field of high-performance circuit boards.

New solutions with improved properties

As the mount for the various components, the circuit board is the most important element in electronic interconnection technology. Components are assembled or etched onto the board and electrically connected to each other by copper circuits. In particular, the highly integrated components with several hundred connections require a lot of space on the circuit board, which is often not available because of the ever-increasing miniaturization in microelectronics. The challenge is that new generation electronic devices are supposed to be smaller and lighter, while at the same time offering more functions.

Although it is true that today's standard materials will continue to play an important role in circuit board production, the demand for innovative alternatives with optimized properties is nevertheless growing. There are several reasons for this trend. First, the structures that are printed on the boards are becoming increasingly more complex. Second, the speed of data transmissions is reaching higher and higher levels. And third, environmental concerns are gaining more and more weight.

As a result, materials for circuit boards must meet ever-increasing demands that cannot be fulfilled with conventional products. For instance, extremely fast transmission rates of more than 2.5 gigabyte per second are now

Glass

New high-performance circuit boards achieve transmission rates of more than 2.5 gigabyte per second. As a base material for multilayer laminates, thin glass offers very good prerequisites because of its extremely low dielectric loss factor.

the order of the day. And the data have to be electrically transferred trouble free and with as little loss as possible. In addition, the density of the connections and the heat created in the circuit board as a consequence of higher performing components are steadily increasing. Thin glass offers very attractive possibilities as a base material for multilayer laminates to meet these future prerequisites. In its simplest form, the laminate consists of a thin glass substrate that is sandwiched between two copper foils, which are clad to the substrate by a resin. Several of these layers can then be assembled to multilayer laminates with the help of prepreg layers made from glass fiber reinforced adhesives.

Thin glass offers many advantages

"The thin glass laminate is especially attractive because of its extremely low dielectric loss factor, which is crucial for a trouble-free transmission of high-speed signals," explains Dr. Mathias Dietz, the Project Manager in Isola's R & D Department who is responsible for this development. Another outstanding property is the low linear thermal expansion coefficient of glass, which is within the range of ceramics (four to six ppm/K). When the components on a circuit board are in use, they trigger alternating heating and cooling processes, which experts call "breathing." The greater the difference between the expansion of the board and components, the higher the stress on





The laminate preforms are processed in the press at temperatures of 180° C to 200° C.

The substrate glass type AF 45 is produced in Grünenplan based on a so-called down-draw process. "We are constantly improving this process to meet the demand of the electronics industry for increasingly larger formats, explains Dr. Andreas Weber, Plant Manager of Schott Displayglas GmbH.

The production of semifinished products in Düren begins with the cladding of the adhesive-coated copper foil onto the glass. As many as 40 of these laminate preforms – each separated by special paper – are fed into the press, which can accommodate up to six of these stacks. Depending on the resin system used, the process operates at temperatures between 180 to 200° C, and the pressing time varies from 75 to 120 minutes." More detailed pa-

Innovations offer major market opportunities

Sales of high-performance laminates are still booming. The U.S. market research company Prismark expects growth from 3.6 to 9.4 million square meters between 2000 and 2005. The main focus is on high-speed multilayer printed circuit boards, special radio frequency laminates and substrates for integrated circuits (ICs). These systems are required for high-frequency transmissions, for instance in mobile phones, in the infrastructure for UMTS networks and in the nodal centers for data traffic. The new circuit boards thus attracted a lot of attention at recent major technical conferences like the Electronica and the Productronica. "Companies like Motorola, AT&T, Cisco, Nokia and SonyEricsson showed great interest, in particular because of the many advantages of the new laminates, which can be well integrated into existing production processes," reports Dr. Cygon.

the sensitive soldered joints. In the worst case, the fine base can even break. This is why there is such a great interest in materials that "breathe" as little as possible when exposed to heat. And in principle, this is what thin glass can offer. Isola has also improved the adhesive layer, which would allow the direct mounting of semiconductor chips onto the board without any auxiliary agents, thus offering new ways to reduce the cost of system integration in the future.

Further advantages of glass are its good thermal conductivity and resistance. It is also friendly to the environment because it contains no hazardous substances, such as flame retardants. Another important aspect is the fact that the parameters for the processing steps, which include drilling, pressing, etching and throughplating, only have to be slightly adjusted. This means that no major investments will be required to change the machinery.

"Schott is the worldwide leader in the field of thin glass. Some 60 percent of all thin glass displays for mobile phones are equipped with material from this producer, and this is why Schott is an excellent partner for us," praises Dr. Manfred Cygon, Director of R & D Europe at Isola AG. Glasses in thicknesses ranging from 30 to 1000 micrometers are manufactured at the plant in Grünenplan. The 100-micrometer substrates are used for circuit board production. Laminate sizes of 450 by 370 millimeters are currently available, but the aim is to produce much larger dimensions.



The structure of a multilayer laminate: a copper foil is clad to both sides of the thin glass with the help of a resin. Intermediate layers made from glass fiber-reinforced adhesive join the other layers.

rameter profiles are our manufacturing secret," notes R&D expert Dr. Dietz. This procedure is followed by cool pressing during which the laminate is carefully reduced to room temperature. Isola has also developed new methods for the subsequent processing steps. One example is cutting the boards without breakage.

Meanwhile PPC Electronic AG is working intensively to increase the production capacity for the new circuit boards. "We are now implementing the process qualification. This includes mechanical processing, which requires several thousand drillings per board. Since glass is brittle, certain adjustments are necessary," explains Peter Weber, member of the Board of Management and Director of Development at PPC. By the end of the year, the PPC experts in Cham hope to be able to present the first products. The company sees major market opportunities for high-tech applications in telecommunications and chip production, but also in the automotive sector where temperature stability and the reliability of components for control and brake systems play an important role. Thanks to these application possibilities for thin glass circuit boards Peter Weber has set his sights on an ambitious goal: "If we gain a share of 29 percent in the growing high-end market, it would be an enormous success." ◀