Dirk Diederich is the founder and CEO of the Institute for Glass and Raw Materials Technology (IGR) in Göttingen. He has more than 20 years of experience in glass technology and has been a publicly appointed expert in this field since 2020. He also identifies and analyzes foreign bodies such as glass, plastics, and metals for the Lower Saxony State Office for Consumer Protection and Food Safety

“There are many ways to make glass more sustainable”

As a packaging material, glass faces tough competition from plastic, tinplate, and cardboard—and offers clear advantages when it comes to recycling. Dirk Diederich, CEO of the Institute for Glass and Raw Materials Technology in Göttingen, explains in which applications glass can perform particularly well—and how it can be optimized even further

INTERVIEW **NADINE ALBACH**

At the IGR, cullet mixtures are examined to determine how the mixture affects further processing into recycled glass

Mr. Diederich, why is glass so suitable for food packaging?
It is infinitely malleable and therefore offers all kinds of possibilities for designing packaging. It’s also practically infinitely recyclable because it can be melted down again and again without compromising quality. Glass is practically inert, so it hardly reacts chemically: It neither releases substances nor changes itself. This inertness is a top priority for the food industry and the pharmaceutical sector. Glass is also gas-tight. This is important for medicines, but that’s not all. If you leave a plastic mineral water bottle in the car in the sun, for example, it swells and carbon dioxide escapes.

Nevertheless, there is competition from other forms of packaging such as plastic, cans, and drink cartons. They outperform glass, especially in terms of weight.
That’s right. Plastic bottles, for example, are actually lighter and cause less carbon dioxide emissions during transportation. But plastic can’t be recycled at will. I can’t easily make a new product from a batch of 100% recycled plastic, because the molecular chains have become shorter. I need new polymers every time, and most of them are made from crude oil. Plastic also has the disadvantage that substances can migrate from the plastic into the product and change the taste, for example. In the EU, many plastic additives are subject to strict limits that are regularly reviewed. Glass therefore comes into its own with sensitive foods, because it is practically inert.

And how does glass compare with cans or drink cartons?
Metal cans are not inert. That’s why they are provided with thin polymer coatings on the inside for corrosion protection—for tomato paste, for example. Substances can then be released from the coating. And as for the drink cartons, some time ago, the Federal Environment Agency came to the conclusion that they are very environmentally friendly because they weigh less. But that’s only half of the story. It’s important to remember that cardboard is made up of different composite materials that are difficult to separate. And if I want to make something new out of the paper, I have to add new fibers. Furthermore, as far as I know, the old carton, without the current plastic closure, was used for the life cycle assessment. →

Before the actual measurement series starts in the laboratory, sample solutions are prepared in volumetric flasks

“Because I can produce glass entirely from cullet, this alone can save up to 30 percent of the primary energy”

Despite their advantages, bottles and other glass containers are under pressure. In recent years, global production has shrunk by around 20 percent. Production sites in Germany have been closed. What’s the explanation?

We don’t yet know all the reasons for this trend. This is because all packaging in the food sector has lost ground—cardboard and PET bottles have lost a lot, while glass has only lost a moderate amount. We suspect that consumption has changed, because we’re seeing this development in all packaging materials. It’s clear that the beverage can is currently “in,” especially among young people—with energy drinks, for example. From a marketing point of view, glass is probably more “old school” here at the moment. In addition, glass bottles are no longer permitted at mass events due to political regulations, because people could injure themselves. In South America and South Africa, on the other hand, the glass market is growing significantly.

How can the industry strengthen glass packaging in the future?

Clearly by focusing more on sustainability. There are many levers, starting with the material. For example, you can increase the proportion of cullet from recycling during production, because this greatly reduces energy consumption compared to new glass—for every ten percent of cullet, I save three percent of the energy. Because I can produce glass entirely from cullet, this alone can save up to 30 percent of the primary energy. Packaging material accounts for up to 50 percent of the carbon footprint of food. In this respect, the food industry is thinking very carefully about which packaging it should use. For high-class products, where the color of the glass is also important, we can achieve a cullet content of around 40 percent. For other products, up to 100 percent.

And what can be done about the weight?

Thin walls really are a major topic. They save raw materials and energy during production and make the packaging lighter—which in turn saves fuel during transport. Thin walls are of particular interest for disposable containers, which are often transported over long distances. Forty-eight percent of all glass containers in Germany are disposable, so saving material is an effective lever. Glass has already become thinner over the decades, thanks to new technical processes. In addition, the wall thickness has become more and more uniform. But we’re still a long way from the end. In the meantime, reusable beer bottles that are significantly lighter than conventional ones have also been introduced.

How can that be implemented technically? After all, bottles and glasses aren’t supposed to break.

New forming processes, targeted temperature control along the production process, and better monitoring with the help of AI and camera technology can all make thinner glass stronger. Of course, there must be no unintentional glass breakage. Contamination with foreign bodies and glass splinters during the filling process must be prevented. New coatings such as those from TotalEnergies and Evonik can also help here, as they are able to protect the glass even better against scratches and damage. In addition, this reduces the consumption of tin.

Glass expert Dirk Diederich in conversation with *Elements* editor Nadine Albach

What other measures can be taken to make glass even more sustainable?

Increasing recycling rates even further—not just in Germany and Europe, but worldwide. Germany, Austria, and the Netherlands were the first to establish glass recycling in the 1970s. In Germany today, more than 80 percent of glass is recycled rather than thrown away. In the meantime, however, other countries such as Switzerland, Norway, and Sweden have overtaken us. It's also good to know that other countries have caught up massively. Hardly any recycling used to take place in Spain or Italy. Today, these nations are also reaching high values—unlike the United States, where the figure is less than 30 percent. There, but also here in Germany, it's important to continue encouraging people to dispose of used glass correctly.

Recycling is one thing. But can you still tease something out of the material itself?

Of course, through further energy savings in production or through alternative sources of raw materials. Glass is made from the primary raw materials sand and soda—i.e. silicon dioxide and sodium carbonate—as well as dolomite or lime—magnesium or calcium carbonate. It has a relatively high CO_2 load due to the carbonates. In the future, lime could alternatively be separated from drinking water, for example, in order to conserve other lime deposits. The salt obtained in seawater desalination plants could be converted into soda. This sodium chloride could be broken down into its components via electrolysis—the sodium could then be used with water and CO_2 from industry for soda production, and the chlorine could be used to disinfect drinking water.

You just mentioned carbon dioxide emissions. Could the glass industry distinguish itself here in the future by making savings?

Clearly yes, it must. This is because the entire industry in Europe is under massive pressure as a result of trading in CO_2 certificates. I see a multi-stage process here. We need to recycle more and use CO_2-neutral raw materials. We have to reduce weight and also work on the coating of the glass surface in order to optimize the whole thing. There are also alternative energy sources—wind, solar, and hydropower. Then we can actually melt glass in the future without natural gas or oil. Whether we use the electricity directly or turn it into hydrogen first remains to be seen. Incidentally, the idea of using electricity is nothing new—it has been done this way for many decades. Glass is melted in furnaces that are normally heated from above with gas. For dark glass, I also have to use electrodes to supply radiant heat from below, because I can't get enough energy into the area at the bottom of the tub via the tub vault alone. The key factors are that the electricity is affordable and comes from renewable sources.

What opportunities do you see for glass in the future?

The use of this material will increase massively—in very different areas. In the future, specially equipped window panes will produce electricity. Buildings can also be heated by radiant heat, as in a conservatory. In general, glass will continue to gain importance in insulation, house construction, and building technology. Because we are now able to produce increasingly thinner glass, we can also save a lot of material. The automotive industry is tending to go back to glass for certain plastic parts, such as lenses for LED headlights, because of the high quality. And then there's even the idea of storing data in glass, in huge quantities. For the food sector, I expect to see a return to glass in some areas because of its unique properties.