How table sugar solves industrial grade micro- and nanocomponent manufacturing issues.

A life without electronic devices appears to be unimaginable nowadays. We rely on them, since they make our lives easier. However, as technology progresses, newer electronic components keep getting smaller, reaching down to the micro- and nanoscale. Consequently, they require more complex manufacturing methods. Mass production methods appear extremely complex and dangerous, including toxic chemicals, and they are limited to printing components on perfectly flat wafers. This makes applications of those components impossible in many fields, such as medicine or industrial manufacturing. Just now, a common baking ingredient provides a solution to those complications: sugar.

Among all the methods that have been developed, transfer printing became a common way of printing those microscopic components. The key idea of transfer printing lies in picking up existing components and putting them back on a separate accepting substrate, with a transfer medium. Currently, this method has commonly been used to transfer components in medical and optical electronics.

However, with the development of small-scale electronics, even this method brings inconveniences: printing on very curved and uneven surfaces still appears impossible, due to the geometries of existing round stamps. Yet, this issue seems solved with a substance found in anybody's kitchen, with a method recently introduced by G. Zabow (2022). Zabow introduced common table sugar, as a transfer medium, which provides a reflow ability whilst reheating. Zabow himself previously managed the transfer of gold patterns on hair, poppy seeds, red blood cells, etc, showing that his method overcomes previous complications. Hence, this bachelor's degree project studied Zabow's method, with the goal of extending the application knowledge as a base for future scientific and technical applications. Therefore, Thin film thermocouple (TFTC) sensors were chosen as test electronics to be transferred onto a fiberglass composite substrate. Thermocouples are temperature sensors widely applied in industry when subject to extremely high temperatures. Especially in metal processing industries, TFTCs can optimize industrial work steps for the best quality production results.

The sensors are firstly coated with a solution, containing distilled water, sugar and corn-syrup. Next, the samples are placed in a regular oven, baked overnight and left for cooling. The hardened sugar is then lifted off with a scalpel. Subsequently, the sugar is positioned on the fiberglass substrate and placed on a hot plate. Thanks to the sugar's reflow ability, the sugar adapts to the macroscopic shape of the fiberglass. Lastly, it is dissolved in distilled water, hoping that the TFTC components stay on the substrate. Nothing else is needed to conduct the experiments.

In that way, several experimental attempts were conducted, resulting in a partial success. The transfer of some component parts was successful both on the rough and the flat side of the fiberglass substrate. However, a lift-off error of the TFTC contacts was encountered. While the plus poles hardly came off, the minus poles almost always completely managed to lift-off. Optical characterization of the lifted-off components showed major absorption and damage of the TFTC components inside the sugar. Deeper electron microscopy confirmed that some of the component layers had issues lifting off. This observation was not made in other experiments with gold, raising the idea of some mechanical or chemical phenomena taking place with nickel alloys.

Nevertheless, the method has proven to work to some extent. Continuing research on this method is a step towards a more sustainable and ecologically friendly future. The application of sugar and corn-syrup, purchased in a supermarket, excludes any application of chemicals, expensive equipment and high energy operations. Consequently, costs are getting cut and risks endangering human health are widely excluded. Additionally, Zabow's method opens new doors for urgent applications in medicine, technology and engineering, which can lead to even more important discoveries. On top of that, it offers solutions to issues with traditional component manufacturing methods.