

Economic LED recycling

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LED-based lighting elements are currently available in a variety of different forms. To recycle them efficiently they must first be broken down into their constituent parts. When recycling the LED diodes themselves it is critical that they remain as intact as possible for collection. Credit: Fraunhofer ISC/IWKS

Light emitting diodes are used in a great number of products like televisions and lamps or luminaires. Moreover they are penetrating the

automotive lighting market to an ever greater degree. Nevertheless, there are no suitable recycling processes available today for these items. Researchers have developed a method to mechanically separate LEDs.

Modern illuminants are manufactured using a variety of [materials](#). The housing is made of glass or plastic, the heat sink consists of ceramic or aluminum, and the resistors and cables contain copper. The most valuable materials are found within the LEDs themselves. They are indium and gallium inside the semiconductor diode and rare earths like europium or terbium in the phosphor. This makes it relatively expensive to manufacture the diodes, and the margins are small. "Right now recyclers are starting to receive LED products, but currently they are often simply stored as there is no suitable recycling process available yet. The main goal is to recover the valuable materials. It's only a matter of time until recyclers will have to start processing LEDs," says Jörg Zimmermann from the Fraunhofer Project Group for Materials Recycling and Resource Strategies IWKS in Alzenau and Hanau of the Fraunhofer Institute for Silicate Research ISC.

Separating components with the help of shock waves

Using the "electrohydraulic comminution" process, researchers break the LED lamps into their constituent parts without destroying the LEDs themselves. Shock waves created by electrical impulses in a water bath separate the individual components at their predetermined break points. The components can then be recycled individually. The researchers have adapted their experimental setup to retrofit lamps, which resemble traditional light bulbs or fluorescent tubes and can be used in the same standard sockets. "This method works in principle also for other sizes, for instance with LEDs from television sets or with automobile headlights, as well as with other electronic products," explains Zimmermann.

A prerequisite for an efficient recycling process is a neat separation of the components. "To efficiently separate and recycle all components of a LED lamp, an entirely different approach is necessary - one that produces large quantities of semiconductor and phosphor materials," says Zimmermann. If the entire retrofit is shredded, it is much more difficult to separate the resulting mixture of materials. Breaking LED lamps down to the component level also makes it easier to recover greater quantities of the materials contained in them. This is accomplished by collecting large quantities of similar components in which the concentration of individual elements is already higher. Zimmermann clarifies that this reprocessing is only profitable for recyclers and manufacturers, if it involves larger quantities.

"We're still testing whether the comminution process can be repeated until the desired materials have been separated," says Zimmerman. The researchers can adjust the parameters of the [experimental setup](#) like the type and quantity of the fluid, the container size, or the electric pulse voltage in such a way that separation occurs precisely at the specified break points. "In particular it is the number of pulses that determines how the components will separate," he says. The electrohydraulic comminution process is currently being investigated in detail and improved further, also to gain access to other LED application areas. "Our research has demonstrated that mechanical separation is a viable method for improving the economics of LED lamp recycling," says Zimmermann.

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