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Extract from the annual report 2018
To the website: www.ist.fraunhofer.de/en.html

DIAMOND CLEANS DRINKING WATER IN AFRICA

More than 100 million people in rural areas of Southern Africa have no or only restricted access to clean drinking water. With the goal of developing a decentralized and energy self-sufficient solution for drinking water treatment for rural regions in Africa, the Fraunhofer IST is coordinating a project funded by the European Union under the title "Self-Sustaining Cleaning Technology for Safe Water Supply and Management in Rural African Areas", or SafeWaterAfrica for short. The technological basis for the water disinfection is electrochemical oxidation using diamond-coated electrodes developed at the IST.

Water treatment and disinfection

Rivers and wells, which are primarily used as sources of drinking water in Southern Africa, often contain high concentrations of organic pollutants, heavy metals and pathogens. In the first step of the water treatment, organic constituents and heavy metals are removed using a combination of electrocoagulation, flocculation and filtration. Subsequently, diamond-coated electrodes are utilized for disinfection in order to kill fungi, algae, bacteria and viruses with the aid of electrochemical oxidation (see Figure 1). The special challenge lies in designing components able to withstand the conditions prevailing in remote regions.

In September 2018, the first demonstrator built by South African partners was erected in Waterval near Johannesburg (see Figure 2). Solar cells and a battery will enable self-sufficient operation independent of unreliable or non-existent power networks.

Improved long-term stability of diamond electrodes

Within the framework of the project, the Fraunhofer IST developed a new concept for improving the long-term stability of diamond electrodes. The novel diamond electrodes consist of silicon base bodies with a coating of electrically conductive diamond which is only a few micrometers thick. In order that diamond growth is able to take place in the hot-wire CVD process, a pretreatment step, known as nucleation, is required. The denser and more homogeneously the diamond nuclei are applied to the base body, the faster the growth of a defect-free diamond layer and the longer the achievable service life.

Nucleation through bombardment with hydrocarbon ions

In the "SafeWaterAfrica" project, the "Hot Filament Bias Enhanced Nucleation (HFBEN)" process was used for the first time for the nucleation of the diamond electrodes. Nucleus formation takes place directly in the coating reactor through bombardment with hydrocarbon ions which are created in an additional plasma. The advantage of the HFBEN process is that it produces particularly high and uniform nucleus densities, thereby enabling the growth of low-defect diamond coatings with potentially improved service life.

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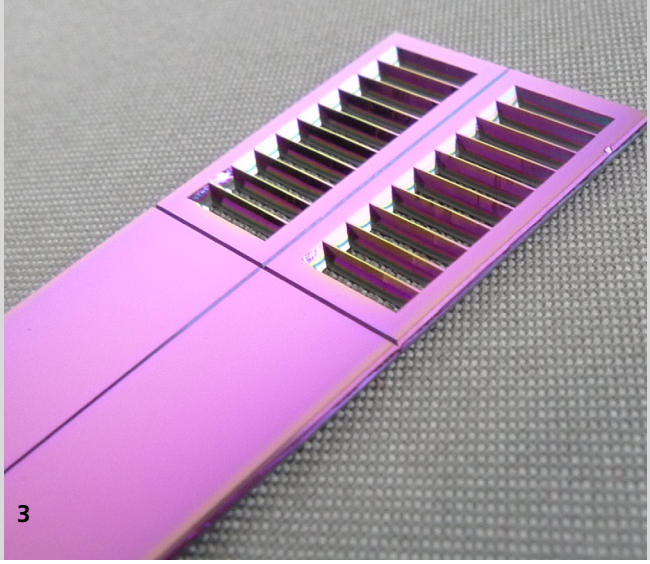

1 *Disinfection unit of the demonstrator with three electrochemical cells connected in parallel with diamond electrodes (housing inscription "SafeWaterAfrica").*

2 *Demonstrator for water treatment during the installation phase in South Africa.*

3 *Electrode after Hot Filament Bias Enhanced Nucleation and a short diamond deposition (the color is caused by interference).*

Outlook

Following the successful installation of the first demonstrator, a second demonstrator is now being set up in Mozambique. In a test phase with a duration of several months, the demonstrators will be tested as regards water quality, failsafe performance and operating costs. Simultaneously, business models will be developed in order to transfer the technology to real application following conclusion of the project in November 2019.

The project

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