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Water and wastewater treatment

Diamond-powered treatment for water and wastewater

● Advanced Diamond Technologies, Inc. (ADT), a US diamond technology developer, has released its UNCD (ultra nano crystal and diamond) Electrodes for advanced electrochemical water treatment applications.

Boron-doped UNCD thin films deposited on niobium and tantalum substrates, these electrodes are built for use in electrochemical cells, where an electrical current is channelled through the electrode to cause the formation of hydroxyls in the water being treated, breaking down pollutants.

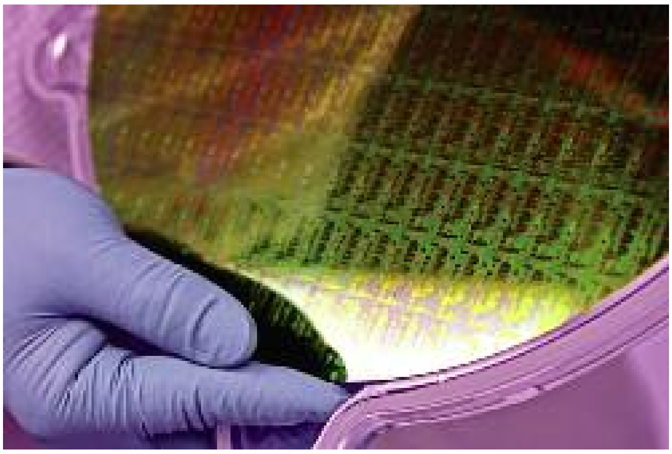
John Carlisle, co-founder, CTO and Acting CEO of ADT, says that there are three main categories of electrochemical treatment in which the diamond electrode could be used – the electrochemical advanced oxidation process (EAOP), on-site generation of oxidants, and ozone generation.

'In [EAOP] you are generating hydroxyl ions on the diamond surface and the treatment technology is typically applied to wastewaters, either industrial or municipal,' he explained to *Water21*. 'Water is flowed through the cell and the inactivation occurs directly on the diamond electrode. In that case, the reason why you would use diamond in this is that it is the most efficient electrode at generating hydroxyls, on an energy basis.

'[On-site generation] is relatively new. This is where you're running a brine of sodium chloride etc. to generate hypochlorite, mixed oxidants, persulphates, and so on. The reason why this is new is because diamond is not typically thought of in this application...About a year ago we discovered that we could run our diamond electrodes, enabled by what we call UNCD. We could run those electrodes up at hundreds of milliamps per cm^2, which is the regime you need to be in for you to cost effectively generate oxidants on scale. Of particular interest to us is mixed oxidant generation, which is a more potent mixture of oxidants that is capable of removing biofilms. In general you're looking at uses that span disinfection application, waste treatment applications, cooling towers, clean in place, just about anywhere where you can think of using bulk delivered oxidants.

'The third area is ozone generation. Diamond is one of the most efficient ways to generate ozone, at least at some scales.'

Carlisle says that it is diamond's particular properties that make this substance of particular interest for electrochemical treatment, including it's robustness and resilience to strong chemicals. 'Diamond also allows you do what's called reverse polarity,' he says. Scale builds up as calcium and magnesium precipitate out of solution, 'and if you don't reverse polarity or do something about it, the cell will quickly over a period of days to weeks stop working. With diamond you can flip the polarity from plus to minus to de-scale in just a few seconds, and it doesn't destroy the electrode. That is emerging [as one of the most important] attributes of diamond, in addition to being able to generate oxidants very efficiently.'



A UNCD Wafer – one of ADT's diamond products

An area of particular interest to ADT, says Carlisle, is the regulation of contaminants such as pharmaceuticals and herbicides in industrial and municipal wastewater, chemicals which, he says, cannot be broken down by traditional wastewater treatment processes. He sees electrochemical oxidation as an environmentally-friendly method of destroying these organics before treated water is returned to waterways.

'This is a game-changing technology,' concludes Carlisle. 'We're focused on enabling other companies to build better electrochemical technologies, better water treatment technologies, using electrochemistry, using diamond.'

Catherine Fitzpatrick

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Testing and analysis

Results in hours with new quick water quality test kit

● Scientists from MCEARD, the Microbiological and Chemical Exposure Assessment Research Division of the US Environmental Protection Agency (EPA), and NanoLogix, Inc., a US biotechnology company, have been working together through a Cooperative Research and Development Agreement (CRADA) to test a procedure for increasing recovery rates of *Cryptosporidium* and *E. coli* O 157:H7 from source water samples. The overall aim is to improve and quicken the recovery of *Cryptosporidium* oocysts in source waters via NanoLogix's new filter membrane procedure, developing a standardised test for water contamination.

'The EPA approached us three years ago at an American Society for Microbiology annual meeting and asked if we would be interested in working on a comprehensive water quality test kit development with them for use in all ten EPA regions,' explains Bret Barnhizer, CEO of NanoLogix. 'The federal government has a cooperative research and development agreement process with various agencies and those agencies enter into CRADAs with companies, organisations, or universities with the idea of developing certain technologies to benefit the public.'

NanoLogix are currently in a trial and development period for a quick test for *E. coli* and *Cryptosporidium* contamination in drinking and source water, 'and now the CRADA's being expanded to include non-tuberculous microbacterium (NTM) and further work on *E. coli*, and now they're also talking about viruses', says Barnhizer.

Sending samples away for laboratory testing can take up to ten days to get results, says NanoLogix, so there is a need for a quick on-site test that provides the necessary information to determine if live pathogens are present, and if so, the extent of the contamination.

'We use magnetic particle separation to detect what's in the water, and [for example] isolate *Cryptosporidium*, which is a very difficult microorganism to isolate from other types of microorganism, organism, protozoa, or bacteria,' says Barnhizer, '[but] we're able to do it, and in an amazingly short period of time, because it usually takes weeks to find *Cryptosporidium*.' The test consists of a nanochannel filter and magnetic particles with antibody floating on them react with the target pathogen, isolating it for analysis. 'As I've told people many times, we don't make anything grow faster, we just have the ability to see it faster,' he concludes. **CF**

● **www.nanologix.com**