Development of New Boron-Doped Synthetic Diamond Electrode for Extreme Electroanalysis Sensing Applications

At Pittcon 2013, **Element Six** (Luxembourg), world specialists in synthetic diamond supermaterials and member of the De Beers Group of Companies, announced that it has engineered DIAFILM EA (Electroanalysis grade) in collaboration with The University of Warwick.

The free-standing, solid boron doped microwave chemical vapour deposition (CVD) diamond electrode is expected to transform sensing technologies, allowing the development of next generation advanced electroanalysis sensing systems to benefit the biomedical, environmental, food, pharmaceutical, and oil and gas industries.

DIAFILM EA benefits from being chemically inert and stable, overcoming long-term stability issues in the harshest of environments such as in corrosive and elevated temperature and pressure operations. In many of the most demanding of electroanalysis applications, DIAFILM EA has the ability to perform thousands of cycles, whereas other electrode materials only survive a single use. This is combined with high phase purity and optimum levels of conductivity, enabling the highest level of sensitivity, selectivity and responsiveness.

With the introduction of the new DIAFILM EA, Element Six is now actively collaborating with commercial partners to enhanced electrochemical sensing applications leveraging the proven performance of this next generation sensing material. With the widest solvent window of any electrode material, and the lowest background current and capacitance, DIAFILM EA is expected to transform the business economics of electroanalytical sensing systems and technologies.

"For the past decade or so, thin-film boron doped diamond electrodes have not delivered on their technical promise, as the industry has struggled to combine the necessary level of conductivity with the required phase purity," said Adrian Wilson, head of technologies at Element Six. "We have manufactured a grade of boron doped CVD diamond with the ideal optimal conductivity, combined with 100 percent phase purity to meet this market need. Given its unique properties, DIAFILM EA will advance tomorrow's sensing systems."

"The research and development of synthetic diamond as an electrode material has exposed its potential to transform the future of sensing technologies," said Julie MacPherson, professor, the University of Warwick. "Element Six's CVD diamond is an exciting material to work with, and one we've enjoyed working with throughout our six-year research collaboration with the company."

The synthetic diamond technical work was completed by the Element Six R&D team based at Ascot in the United Kingdom, and is a result of more than 15 years of research and development. Electrochemical characterisation testing of DIAFILM EA was carried out by the Electrochemistry and Interfaces Group in the Department of Chemistry, at the University of Warwick.

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New On-line Cyanide Analyser to Help Gold Milling Operations

Xylem's OI Analytical (USA) announce the launch of a new on-line cyanide analyser for gold milling applications. The new CNSolution 9310, when incorporated into the gold milling process, can facilitate significant cost savings for mill operators.

Most gold occurs at very low concentrations in ores; less than 10grams/ton (0.001%). Hydrometallurgical extraction using cyanide is the only economically viable method of recovering gold from such low-grade ore. Leaching solutions typically contain cyanide in concentrations from 50 to 2,000ppm, and purchasing, transporting, handling and detoxifying cyanide is a major operating expense for gold mills.

Accurately measuring cyanide available for leaching gold from ores containing copper and metallic sulphides is problematic, since copper complexes with cyanide and reduces the amount of cyanide available for leaching. To complicate the process further, titration methods commonly used for process control do a poor job of measuring available cyanide when copper is present. An excessive amount of cyanide must be added to the leaching solution to compensate for this measurement inaccuracy and to ensure a sufficient concentration is present for efficient extraction of gold.

Adding excessive cyanide in the leaching process decreases the efficiency and increases operating costs associated with the detoxification stage. Gold mills performing cyanidation need to adhere to the International Cyanide Management Code which defines good practices and guidelines for use, treatment and disposal of cyanide. The code sets a limit of 50mg/L in tailings solution discharges, and to comply with this limit the spent cyanide solutions must be detoxified. Detoxification requires the use of strong oxidising agents to destroy cyanide and reduce its concentration, adding yet another layer of expense to the milling of gold.

OI Analytical's CNSolution 9310 On-line Cyanide Analyser measures available cyanide in precious metal leaching solutions per U.S. EPA Method OIA-1677 and ASTM D 6888-09. The gas-diffusion amperometry technique in these methods is proven to be free of interferences from copper and metallic sulphides, providing more accurate measurement of the available cyanide concentration. The CNSolution 9310 responds quantitatively to cyanide, as well as zinc, copper, cadmium and silver cyanide complexes over the entire instrument calibration/measurement range (0.2 to 2,000ppm).

The superior accuracy of the CNSolution 9310 facilitates tighter control of the cyanide concentration in the leaching process and oxidising agent usage in the cyanide detoxification process, thus significantly reducing the amount of cyanide needed. A ten percent decrease in cyanide usage can easily translate into a savings of hundreds of thousands of dollars per year in the leaching and detoxification costs for a milling operation.

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INTERNATIONAL ENVIRONMENTAL Technology

The Leading Journal for Environmental Instrumentation

May / June 2013 Volume 23 Issue 3

$$f(z_0)=\frac{1}{2\pi i}\oint_C \frac{f(z)}{z-z_0}\,dz$$

$$\delta \underline{A} = \underline{A}(u+\delta u)-\underline{A}(u) \qquad d\phi=\frac{\partial\phi}{\partial x}dx+\frac{\partial\phi}{\partial y}dy+\frac{\partial\phi}{\partial z}dz$$

$$\frac{d\underline{A}}{du}=\lim_{\delta u\to 0}\frac{\underline{A}(u+\delta u)-\underline{A}(u)}{\delta u}=\frac{dA_1}{du}\underline{i}+\frac{dA_2}{du}\underline{j}+\frac{dA_3}{du}\underline{k}$$

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