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Electrochemical Detection of Silica Species

An inexpensive, miniaturized electrochemical silica detector has been developed at Arizona State University for use in ultrapure water (UPW) systems requiring silica concentrations much lower than 1 ppm. The semiconductor industry is by far the largest user of UPW, but the burgeoning flat panel display and bioscience industries are driving demand growth. This voltammetric detection method competes directly with industry standard colorimetric systems, which measure the absorbance of specific wavelengths of light by a distinct solution. These systems require large volumes of expensive and sometimes corrosive reagents such as Molybdate, Citric Acid and Amino Acid, whereas ASU?s system requires molybdenum, chloranilic acid and acetate. Voltammetry involves preconcentrating species of interest onto an electrode, then selectively stripping each one with a voltage sweep. Analytes are identified by separate spikes in current with very high sensitivity. The compact system can incorporate the auxiliary, reference and working (sensing) electrodes on a single substrate. The electrodes are fabricated with a screen printing process, and sputtered with bismuth. They can be stored in a sealed package, quickly installed, and are disposable, which adds to their convenience. Competitive pricing can dramatically reduce periodic costs of ownership and create demand.

Benefits and Advantages

- Bismuth is non-toxic and environmentally safe.
- Replaces mercury film electrodes.
- Inexpensive to manufacture (Pennies per sensor).
- Cheap and simple electronics for data acquisition minimizes user interaction.
- Auto-sampling and rapid analysis time.
- Single step vs. multiple step sample preparation.
- Expensive and corrosive reagents can be reduced or eliminated.

Potential Applications

- Silica monitoring in Semiconductor or other microfabrication environments.
  - Inexpensive, hand-held silica monitors.
  - Multiple, in-line, flow-through cells to pinpoint sources of contamination.
  - Multiple streams with electrodes tailored to an array of analytes.
- Bioscience processes such as enzyme determinations and trace metal or electrolyte analyses.
- Flat-panel display manufacturing.
- Pharmaceutical solvent monitoring.