MICROSENSORS FOR in-situ MONITORING OF Cr and U IN GROUNDWATER IN DOE SITES

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GOALS and EM NEEDS

- **THIS PROJECT ADDRESSES THE EM NEEDS FOR ON-SITE CHARACTERIZATION OF CONTAMINATED NUCLEAR ENERGY SITES.**

- **THE RESEARCH WILL CREATE POWERFUL AND ECONOMICAL MICROSENSOR SYSTEMS FOR in-situ MONITORING OF PRIORITY METAL CONTAMINATS (particularly U and Cr) IN DOE FACILITIES.**

RATIONALE

CHEMICAL SENSORS, CAPABLE TO OPERATE IN-SITU OR ON-SITE, HOLD A PARTICULAR PROMISE FOR FIELD MONITORING OF METAL CONTAMINANTS.

SUCH DEVICES CAN OFFER IMMEDIATE DETECTION OF SUDDEN METAL DISCHARGE AND RAPID FEEDBACK AND GUIDELINE DURING REMEDIATION ACTIVITIES.

PARTICULARLY ATTRACTIVE ARE NEW SENSORS BASED ON ELECTROCHEMICAL STRIPPING ANALYSIS.

APPROACH:

IN-SITU METAL SENSORS

MICROMACHINED FLOW ANALYZER

REMOTE/SUBMERSIBLE STRIPPING PROBES

SUBMERSIBLE FLOW ANALYZER
'LAB-ON-A CABLE'

ELECTROCHEMICAL STRIPPING ANALYSIS

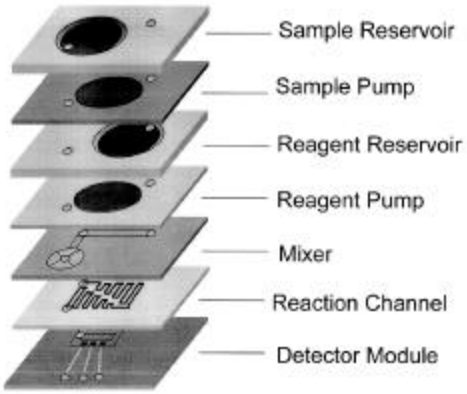
ONE OF THE OF THE MOST POWERFUL TECHNIQUES FOR TRACE METAL MEASUREMENTS. IT REMARKABLE SENSITIVITY IS ATTRIBUTED TO ITS "BUILT-IN" PRECONCENTRATION STEP, DURING WHICH THE TARGET METAL IS ACCUMULATED (by deposition or adsorption) ONTO THE ELECTRODE.

IN ADDITION TO ppt DETECTION LIMITS, SA OFFERS THE ADVANTAGES OF MINIATURIZATION

MINIATURIZED STRIPPING FLOW ANALYZER

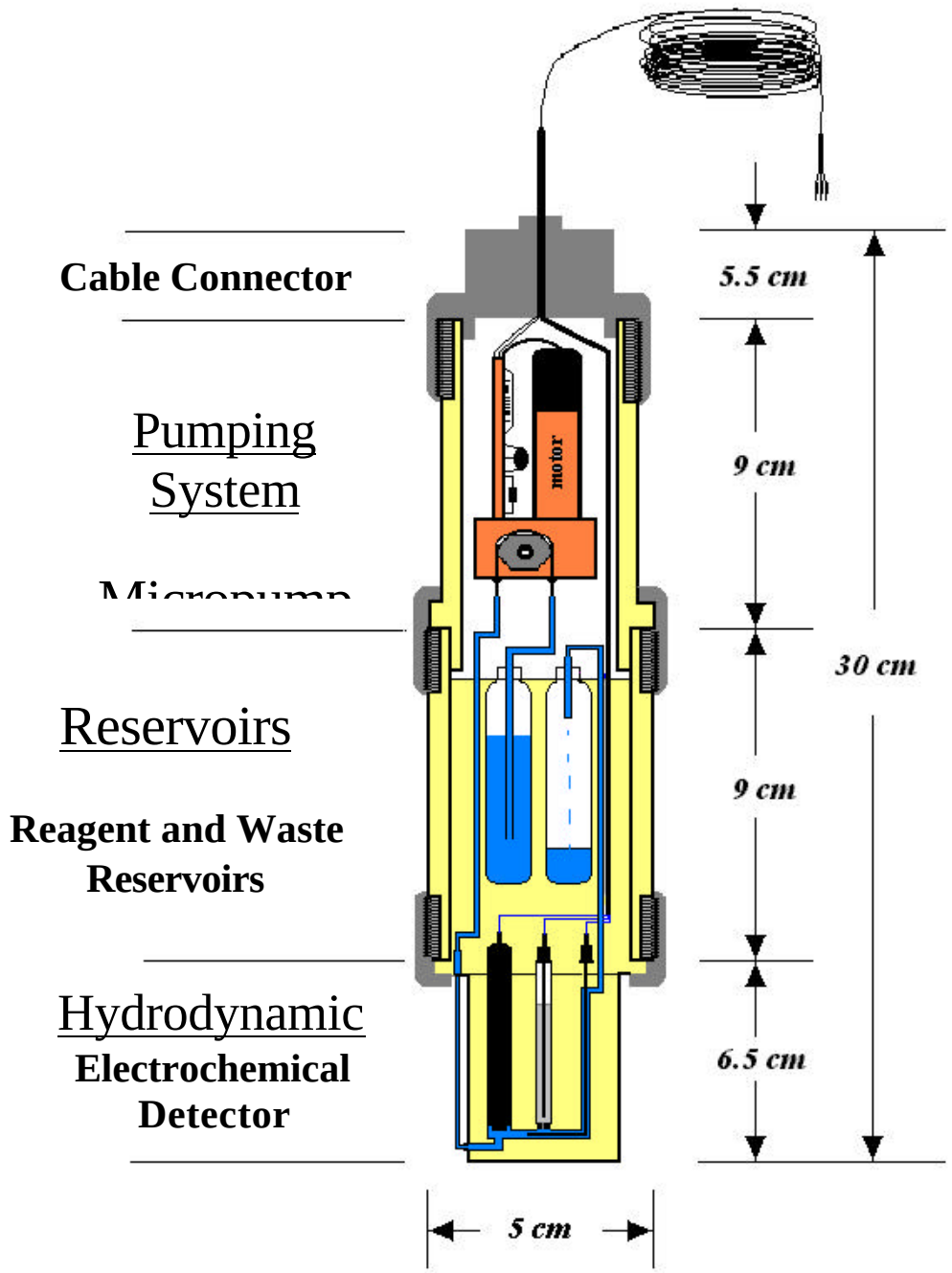
MICROFABRICATED BY MICROMACHINING PATTERNING OF 3D-MICROSTRUCTURES (pumps, channels, etc.).

INTEGRATES ALL THE STEPS OF THE STRIPPING ASSAY (both sample handling and detection), FOR A FASTER AND SIMPLER OPERATION IN A FIELD SETTING.



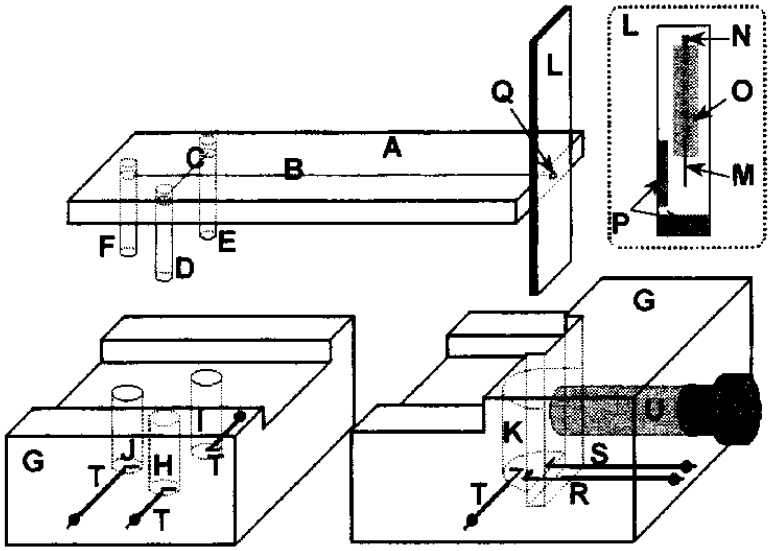
View of the stacked micromachined flow analyzer for adsorptive stripping monitoring of metal contaminants.

NMSU Lab-on-a-Cable

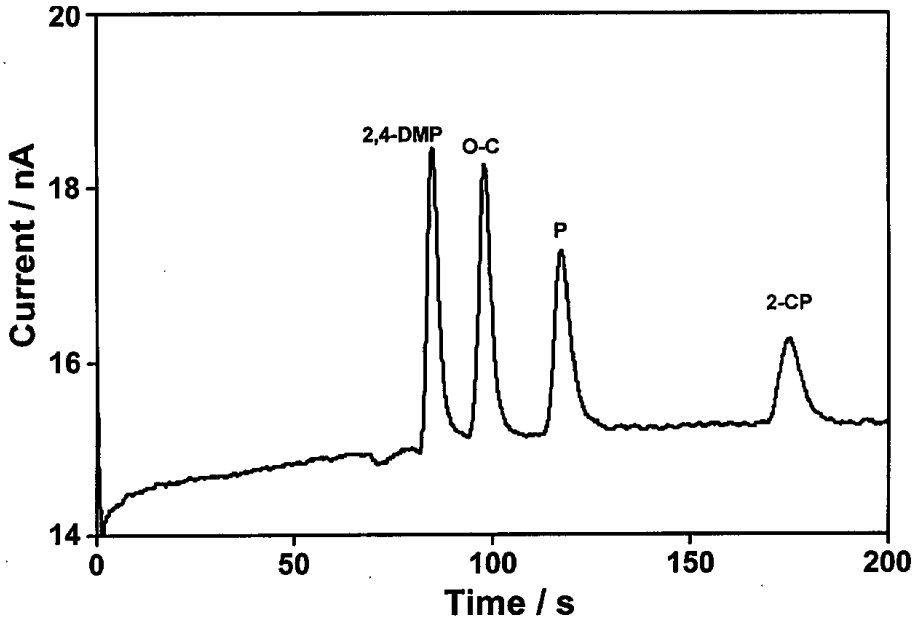


Submersible Sensor for Detecting Priority Contaminants

NMSU Lab-on-a-Chip



Integrated Electrophoresis/Electrochemistry Microsystem



On-chip Separation and Detection of Phenolic Contaminants

List of papers resulted from the DOE Support:

1. "Renewable Reagent Electrochemcial Sensor for Monitoring Trace Metals", J. Wang et al., Anal. Chem. 69(1997)2640.
2. "Simultaneous Adsorptive Stripping Voltammetric Measurements of Trace Chromium, Uranium, and Iron", J. Wang et al., Electroanalysis 9(1997)1247.
3. "Flow Probe for In-Situ Electrochemical Monitoring of Trace Chromium", J. Wang , J. Lu, and K. Olsen, , Analyst, 124(1999)349.
4. "Simultaneous Measurements of Trace Cr and U using Mixed Ligand Stripping Analysis", J. Wang, J. Wang, J. Lu, D. Luo, and B. Tian, Anal. Chim. Acta 354(1997)275.
5. "Remote Electrochemical Sensors", J. Wang, Trends Anal. Chem. 16(1997)84.
6. "Remote Electrochemical Sensor for Monitoring Trace Mercury", J. Wang et al., Electroanalysis 10(1998)399.
7. "Electrochemical Flow Sensor for in-situ Monitoring of Total Metal Concentrations", J. Wang et al., Anal. Communications, 35(1998)241.
8. "Adsorptive Stripping Measurements J. Wang et al., Anal. Chem., 69(1997)1657.
9. "Stripping Analysis into the 21st Century: Faster, Smaller, Cheaper and Better", J. Wang,, B. Tian, J. Lu, C. Olsen and C. Yarnitsky, Anal. Chim. Acta, 385(1999)429.
10. "In-Situ Flow Probe for Improving the Performance of Electrochemical Stripping Analysis", J. Wang,J. Lu, D. MacDonald and M. Augeli, **(invited paper)**, Fres. Z. Anal. Chem., 364(1999)28.
11. "Hot-Wire Stripping Potentiometric Measurments of Trace Mercury", J. Wang, P. Grundler, M. Jasinski, and B. Tian, Anal. Chim. Acta, 396(1999)33.
12. "Renewable Reagent Enzyme Inhibition Biosensor for Remote Monitoring of Cyanide", J. Wang, B. Tian, J. Lu and D. Luo, Electroanalysis, 10(1998)1034.
13. "Anodic Stripping with Collection at Interdigitated Carbon Film Microelectrode Arrays", J. Wang, D. Lou and T. Horiuchi, Electroanalysis, 10(1998)107.
12. "Adsorptive Stripping Analysis of Trace Nickel at Iridium-based Ultramicroelectrode Arrays", J. Wang, W. Adeniyi, and S. Kounaves, Electroanalysis , 12(2000)44.

13. "Remote Stripping Sensor for Determining Copper in the Lagoon of Venice", S. Daniele, C. Bragato, J. Wang, and J. Lu, Analyst, in press (2000).
14. J. Wang, "From Remote Sensors to Submersible labs", **(invited paper),** Lab. Robotics and Automation, in press.

List of Patents (resulted from this effort):

1. J. Wang and K. Olsen, "Remote Electrochemical Sensor", U.S. Patent No. 5,676, 820 (1997).
2. J. Wang and K. Olsen, "Renewable Electrochemical Sensors", U.S. Patent No. 5,942, 103 (1999).

CONCLUSIONS

THE NEW SENSOR TECHNOLOGY WILL REVOLUTIONIZE THE WAY OF MONITORING METAL POLLUTANTS, WILL BRING MAJOR CHANGES TO POLLUTION CONTROL IN DOE FACILITIES, AND WILL SUPPORT THE GOVERNMENT COMMITMENT TO REDUCE THE HUGE COSTS INVOLVED IN THE CHARACTERIZATION OF CONTAMINATED SITES.

(SEE POSTER FOR MORE DETAILS)