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Automated Sample Preparation for CENS Embedded Sensors

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Automated Sample Preparation for CENS Embedded Sensors

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Introduction: Why is Sample Preparation Necessary?

Particulates Will Clog Micromachined Sensors
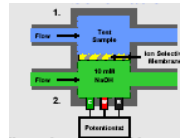
- **Micromachined channels are about 100 μm**
  - Any particles above channel size will clog sensor
  - Even particles less than channel size can clog membranes

Clay	Silt	Sand Fine	Coarse	Gravel

Sand

2 μm   20 μm   200 μm   2000 μm

International Society of Soil Science
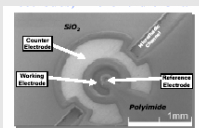
Particle Diameter

Sensors Need Calibration and Fluid Control

- Some CENS sensors require the movement of both samples and secondary fluids in a coordinated fashion
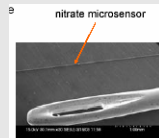- Precipitate out fouling ions to enhance performance

Problem Statement: Sensors in the Environment Need Sample Preparation

Nitrate Sensors Being Developed by the CENS Sensor Group

Micromachined Amperometric Nitrate Sensor

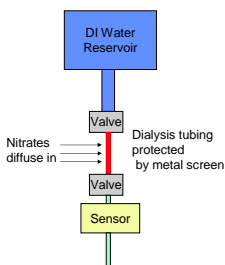**Micromachined Potentiometric Nitrate Sensor**

HPLC Chip Based Chemical Sensing

Needs of CENS sensors:

- small and accurate sensors developed by CENS researchers do not have sample preparation systems, and thus cannot be deployed into the field
- sample preparation systems must be small, low power, and automated

- some applications may require the concentration or dilution of ions to be measured

Basic Sample Preparation Setup: Combines Particulate Filter with a Ion-Diffusion Filter

Sample Preparation Flow Chart
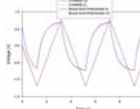

Valves and protected membrane
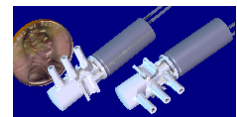
Pumping from soil produces clogs

Dialysis membrane

- Screen protects membrane
- Only small molecules can pass through membranes
- Only diffusion occurs through membrane, so clogging is minimized.
- Sample volume is kept small compared to the surrounding fluid
- The entire fluid volume from entrance to exit is pumped through the system between measurements to reduce contamination between samples
- Chemicals or calibration samples are pumped through as need

Fluidic and Electronic Control

Board Level Potentiostat Comparison to Commercial Unit

Latching Valve (5.5mJ per switch)

Fluidic multiplexer for calibration

Sensor control board

- Board Scale potentiostat is much cheaper and smaller than commercial potentiostat.
- Latching valve greatly reduces power consumption
- Multiplexer allows multiple calibration samples
- Wireless sensor board integrates sensor into network and controls the sensor with a potentiostat, D/A converter, A/D converter, and valve and pump control.