

## **On-Line Measurement Solutions for Mining and Energy Industry**



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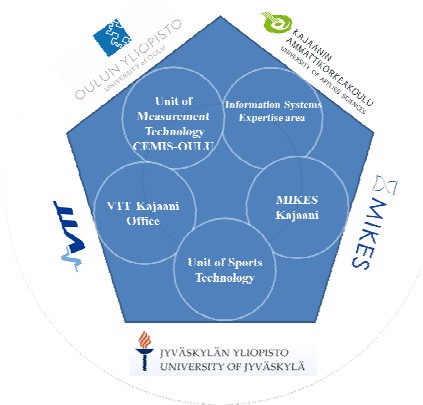
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# CEMIS in a nutshell

# CEMIS

Centre for Measurement and Information Systems



**CEMIS is** a contract based joint centre of University of Oulu, University of Jyväskylä, Technology Research Centre VTT, Centre for Metrology and Accreditation MIKES and Kajaani University of Applied Sciences. CEMIS is founded in 2010 and employs around 110 professionals. CEMIS specialises in research and higher education in the field of measurement and information systems.

**CEMIS's mission** is to provide superior expertise, top-level research services, and innovative solutions for companies and research organizations developing and applying measurement and information systems. For students CEMIS offers an enthusiastic, innovative and international atmosphere to educate oneself toward future professions.

[www.cemis.fi](http://www.cemis.fi)

# CEMIS

Centre for Measurement and Information Systems

## CEMIS Solutions for Mining Applications

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**Optical multisensor for carbon hydrate detection**

Online trace metal sensors

Online multi metal analyzers

Fouling-free sensor solutions

Specialized laboratory analyses

## CEMIS Solutions for Bioenergy and Biofuels Production

**In-flow particle size, shape and quantity meters**

**Detection and characterization of bacteria**

**Fluid flow measurement standards and calibration facilities:**

**Large scale liquid flow test and calibration facilities**

**Lab-scale liquid flow test facilities**

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**Measurement of carbonhydrates in biofuel production**

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- 1) Polarisation spectroscopy**
  - ORD – photometry\*
  - Applicable for rather simple and transparent samples
- 2) Optical multi-measurement**
  - Utilizing spectral complex refraction index and transmission spectroscopy
  - Applicable even chemically and physically complex samples
- 3) Electrochemical sensing**
  - Based on Ni/Co -oxide - MWNT (multi walled carbon nano tubes) – electrodes
  - Aim is to develop sensitive methods to measure selected carbohydrates from biorefinery process streams

Model (g/L)

\* ORD = optical rotatory dispersion  
Rotation of polarization  $\alpha$  as a function of wavelength of light

Arvinte A, Sesay A, Virtanen V, Carbohydrates electrocatalytic oxidation using CNT-NiCo-oxide modified electrodes, Talanta, 2011, 180-186.

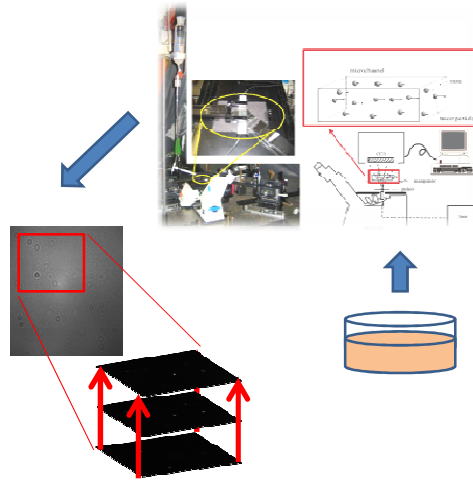
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## Measurement of solid content of bio oils

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- Digital holographic technology is used to realize four dimension information
- Sample cell was filled with a layer of oil and a holographic image was taken
- Stack of cross-sectional images were calculated from the hologram
- Cross-sectional images were compiled into a video for 4D information



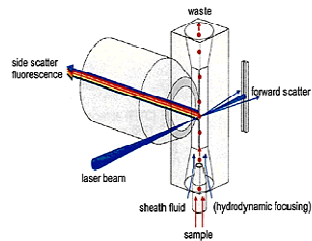
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## Measurement of bacteria in mining processes

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Flow cytometry is a measurement technology used for detection of microscopic particles, counting particles and determining particle size distribution as well as determining their physical and chemical properties



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## On-line sensors for mining industry: On-line detection of toxic substances

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On-line sensors and analyzers based on optical spectroscopy, electro chemical sensors and biosensors for detection of toxic metals and other harmful substances like pathogens, lime-forming substances and bacteria.



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## On-line sensors for mining industry

On-line detection of toxic metals in waste water streams

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**Need:** Ability to measure simultaneously different trace metals at concentration levels down to the fractional parts per billion (sub-ppb), using inexpensive, versatile, reliable, small size instrumentation, with no requirement of special installation

**Conventional electrochemical detection:** Stripping voltametry based on amalgamation on a mercury electrode

**Our solutions for anodic stripping voltametry:**

- 1) Screen printed mercury electrode
- 2) Screen printed mercury-free electrode (based on graphene)
- 3) Gold wire electrode

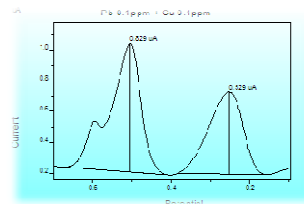
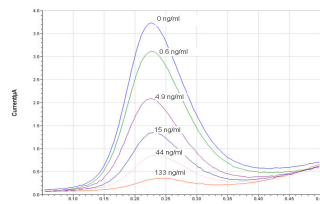
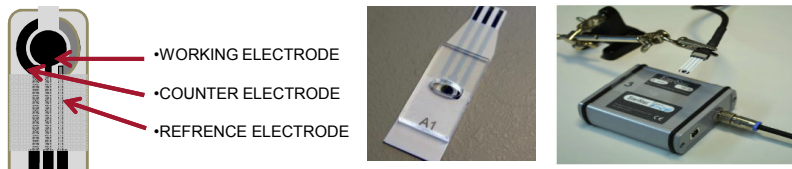
**Our solution for:**

- 4) Amperometric method based on an enzyme biosensor for complex forming metal ions like nickel
- 5) Strip test with colorimetric analysis
- 6) Plasma discharge atomic absorption and emission spectroscopy
- 7) Optical transmission spectroscopy with complex forming reagents

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### Anodic stripping voltammetry by screen printed electrodes

Based on screen printed electrodes developed originally by University of Rome

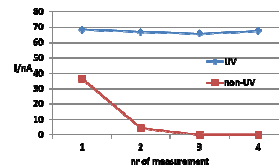


Detection limit: ppb-level

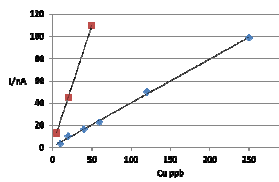
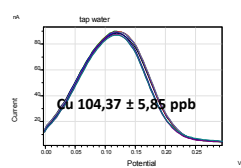
### Gold wire electrode

Based on a 3-electrode configuration with microwire technology originally developed by University of Liverpool. The solution has an integrated solution to prevent contamination of the sensor surface and to increase the selectivity, sensitivity and stability

First prototype



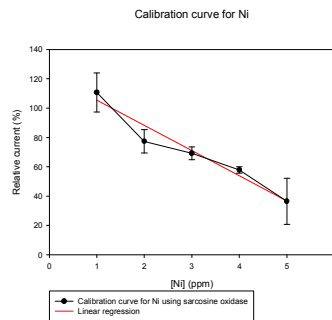
Second (current) prototype



Detection limit: sub-ppb

### Enzyme-based sensors

Enzyme (Sarcosine oxidase) produces hydrogen peroxide that can be measured amperometrically using a modified electrode (Prussian Blue). Nickel inhibits enzyme activity, resulting in lower response detected.



### Field usable optic online measuring instrument for liquids

The instrument can be used to measure metal concentrations in liquid samples with a reagent that forms complexes with metals. The formed complexes absorb light in the visible area. Measurements are based on optical spectroscopy within wavelength range 200 ... 850 nm. Fouling of optical surfaces is controlled with a cleaning solution.

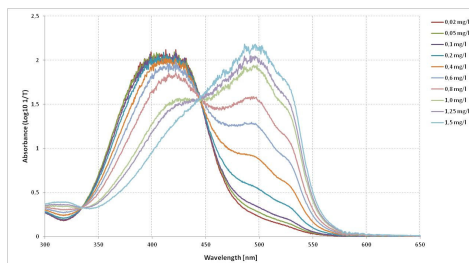
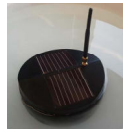


Figure shows the spectra of several concentrations of nickel with PAR (4-(2-pyridylazo)resorcinol) reagent.

Just one dream...



~~Turbidity = 47 FNU~~  
Turbidity =  $47 \pm 5$  FNU



... wireless, self-powered, robust, reliable, self-calibrating sensor network for water quality.

## Reliable On-line Measurements for Demanding Conditions

Thank you!

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Leverage from  
the EU  
2007-2013

