Development of new interfacing techniques for the determination of trace element species

Arsenic Poisoning in Bangladesh

Exploring the largest mass poisoning in history

by Kaylin Pennington

This water looks and tastes normal. The hand pump is noisy and awkward to use, but it produces an abundance of clear water.

But the man being interviewed for the documentary looks resigned. "I think it's better to die than to live like this." He is gaunt and hoarse. His wife explains that he is suffering from lung cancer. "From drinking arsenic-contaminated water," she adds.

This is Bangladesh, the country that now lays claim to the largest mass poisoning in history. The culprit is arsenic, an element that occurs naturally in the environment and can flow through groundwater systems.

Photos courtesy of Sandia National Laboratories.

International aid agencies invested millions of dollars into sinking tube wells in villages across Bangladesh, eventually digging over 11 million wells. Now these wells have contributed to the largest mass poisoning of a population in history.

Twenty years ago, no one in Bangladesh knew about arsenic. Bangladesh is a small country, lush and green, but very densely populated and one of the poorest in the world. The Gross National Product (GNP) per capita is only US $467 (compared to $43,743 for the United States).[1] About 80 percent of the population of 150 million lives in rural areas and depends on farming as a livelihood. While Bangladesh is a country of rivers and floodplains, clean water has always been hard to come by. The rivers (most notably the Ganges) emptying into the Bay of Bengal through Bangladesh originate outside the country, and have become heavily polluted with domestic, agrochemical and industrial wastes. Additional sewage is added to the water as it flows into densely populated wetlands and floodplains of the vast delta that makes up most of Bangladesh, creating a

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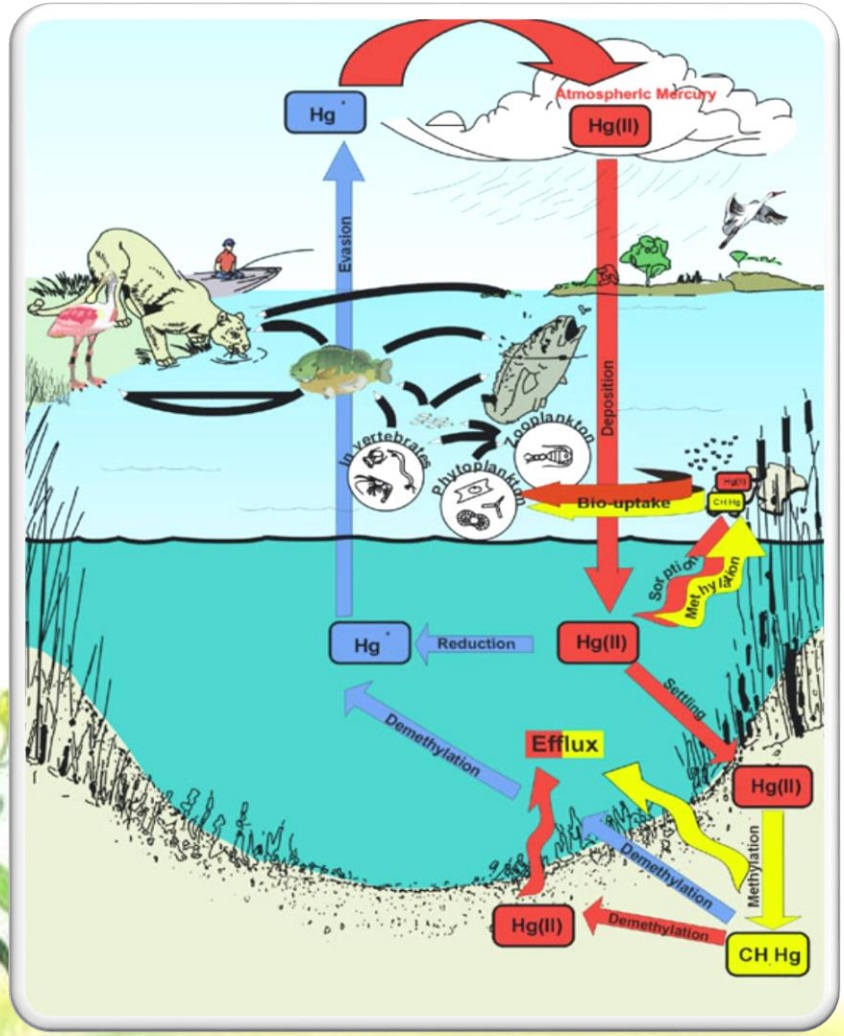
mire of toxic surface water. These natural and anthropogenic conditions have made cholera and other waterborne diseases endemic in Bangladesh, especially during the monsoon season. Many villages are left buried under contaminated water after months of rainfall.

Cholera presents an enormous public health problem in many areas of the world, and in the 1970s it was rampant in Bangladesh. A centralized water treatment system was not deemed technologically, economically, or politically viable by the Bangladeshi government, so a UNICEF- and World Bank-backed solution emerged. Shallow tube wells were sunk throughout the country, tapping into presumably untainted groundwater resources. International aid agencies invested millions of dollars into these tube wells, eventually digging over 11 million wells. Although the incidence of cholera decreased throughout the 1980s, UNICEF acknowledged in a 1990 study that "the use of tube well drinking water has made almost no detectable impact on the rates of diarrheal disease and parasitic infection."[2] Despite this, there was no widespread acknowledgement that the tube wells may have been little more than a superficial development project.

Arsenic can exist in various forms in the environment, some extremely toxic and some harmless. In Bangladesh, the sediments are naturally rich in arsenic, though the most toxic arsenic accumulates deep enough that it does not make its way into surface water. This type of inorganic arsenic (arsenic combined with oxygen, chlorine, or sulfur) has been long recognized for its potency as a human poison; however, natural phenomenon like plant uptake and microbial processes can convert it into harmless, less reactive forms. These natural processes were circumvented, though, when the tube wells pulled water directly from

Speciation of trace elements in waters

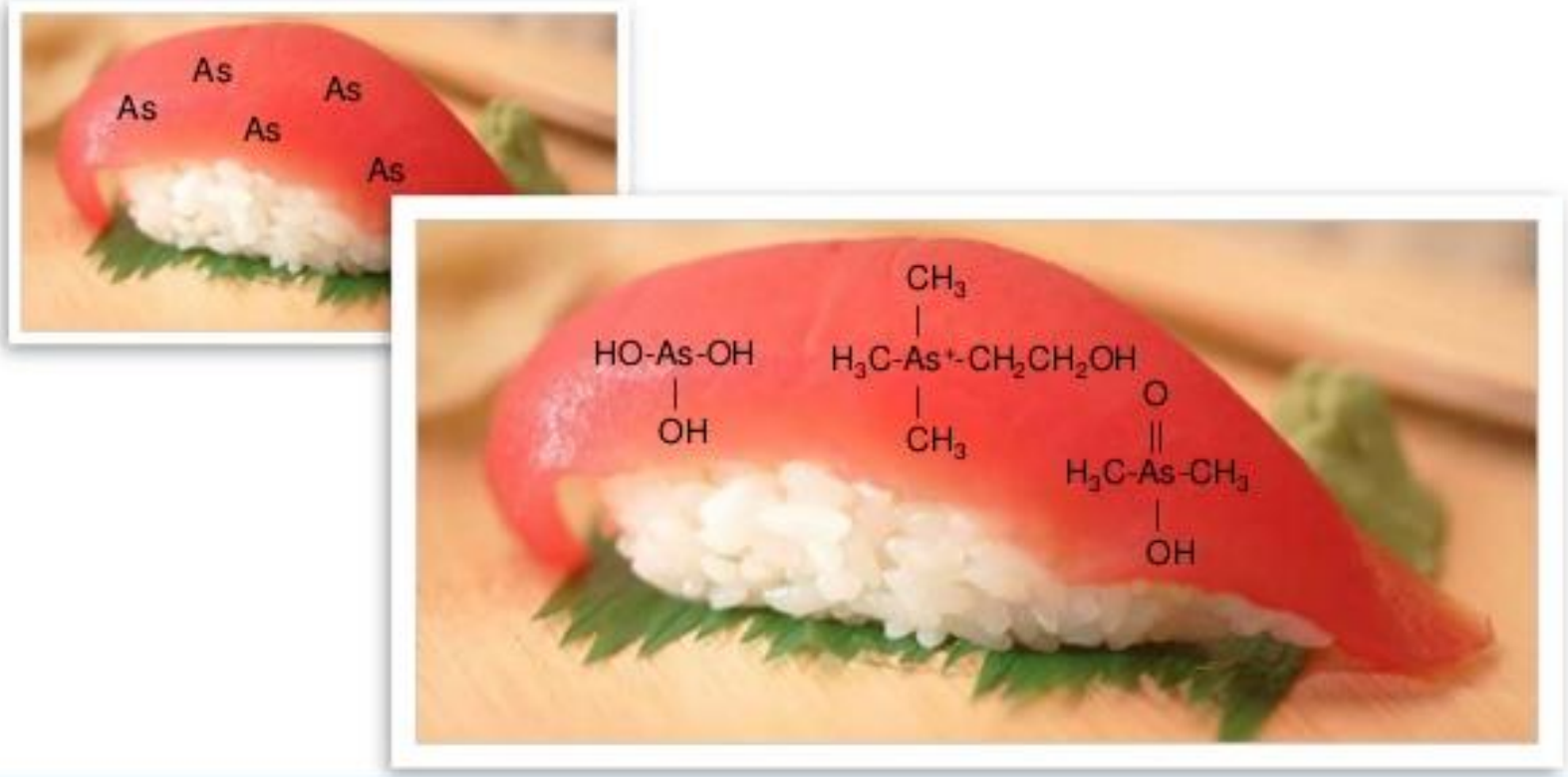


Factors Controlling the State of Metal Ions

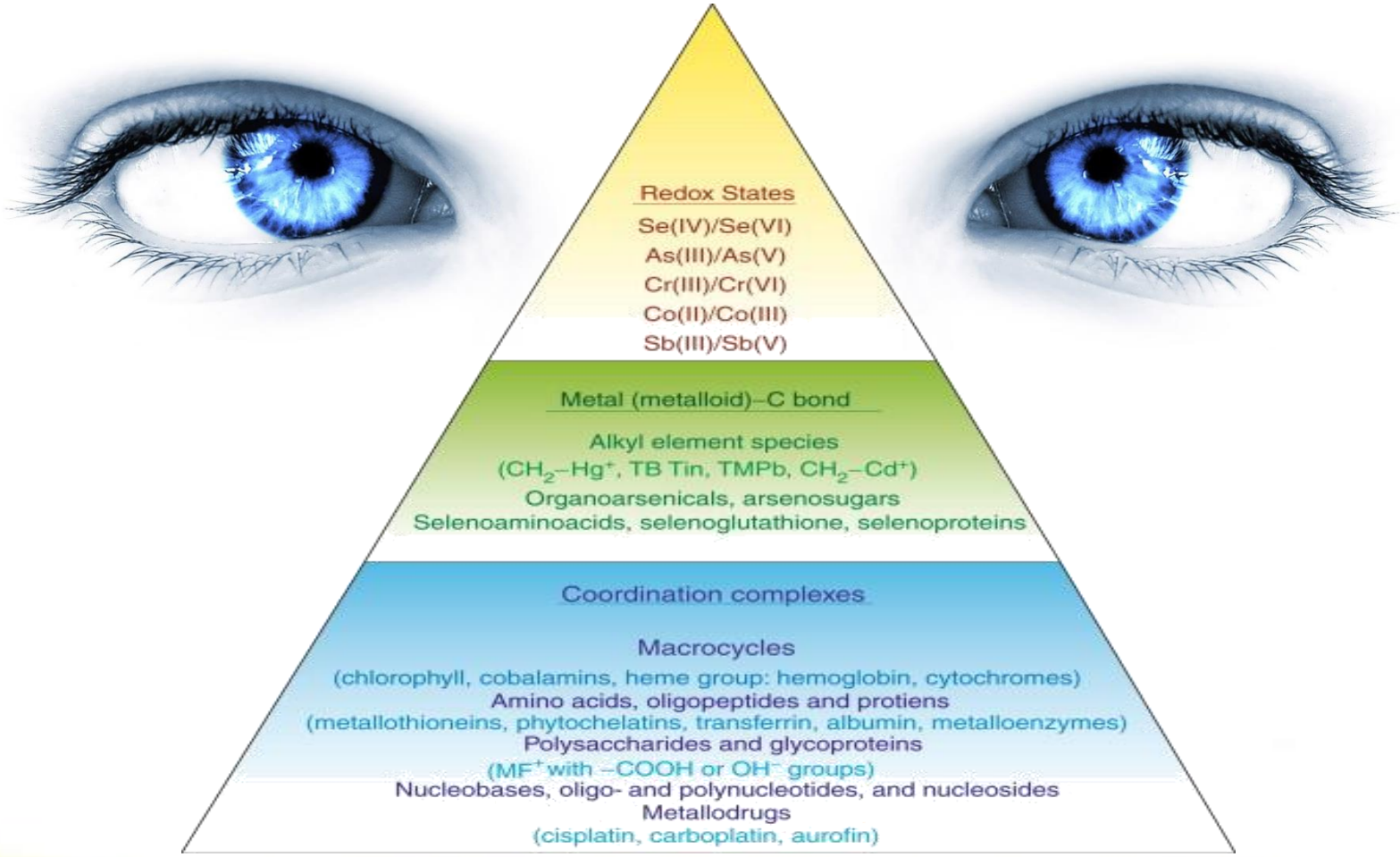
- Oxidation State
- pH
- Biological reaction
- Composition of Inorganic Ligands (OH^-, CO_3^{2-}, HS^-)
- Composition of Organic Ligands (Humic and Fulvic Acids)
- Pressure and Temperature

What is Speciation Analysis?

- IUPAC Definition - the analytical activity of identifying and/or measuring the quantities of one or more individual chemical species in a sample

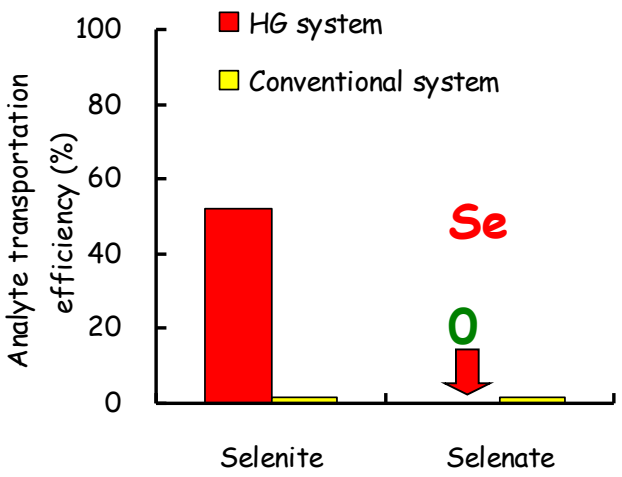


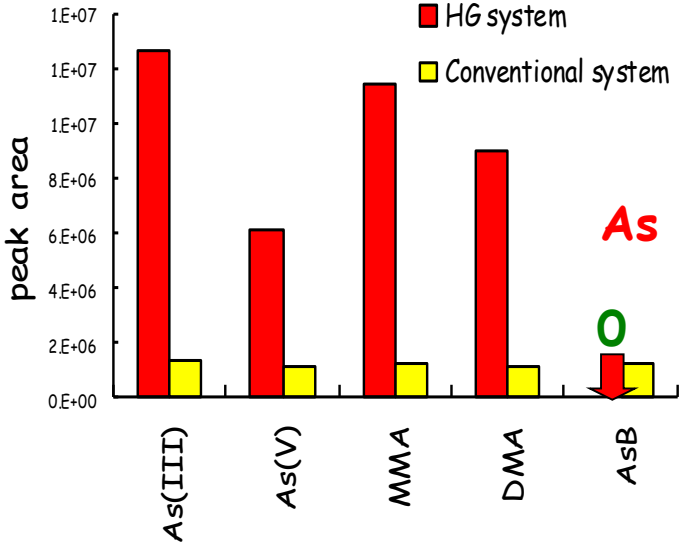
Typical analytes sought in speciation analysis



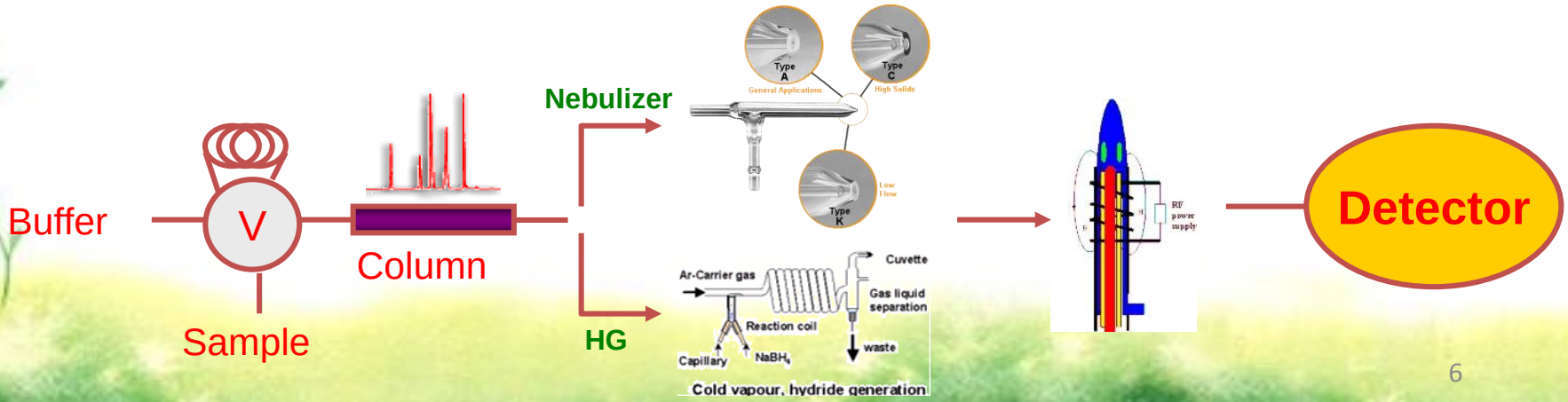
Encyclopedia of Analytical Science null 2005 472 - 480

Determination of As and Se species by conventional methods

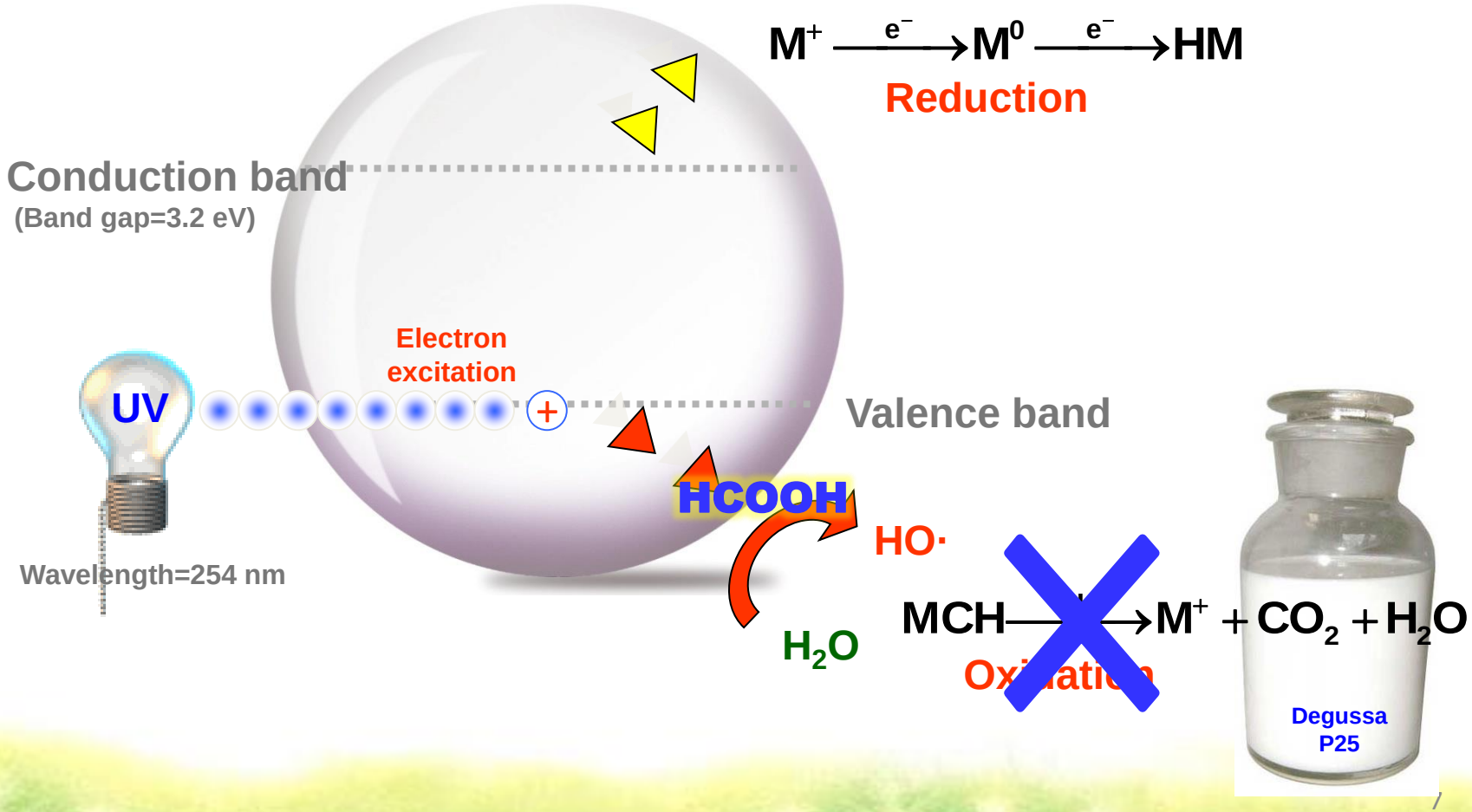




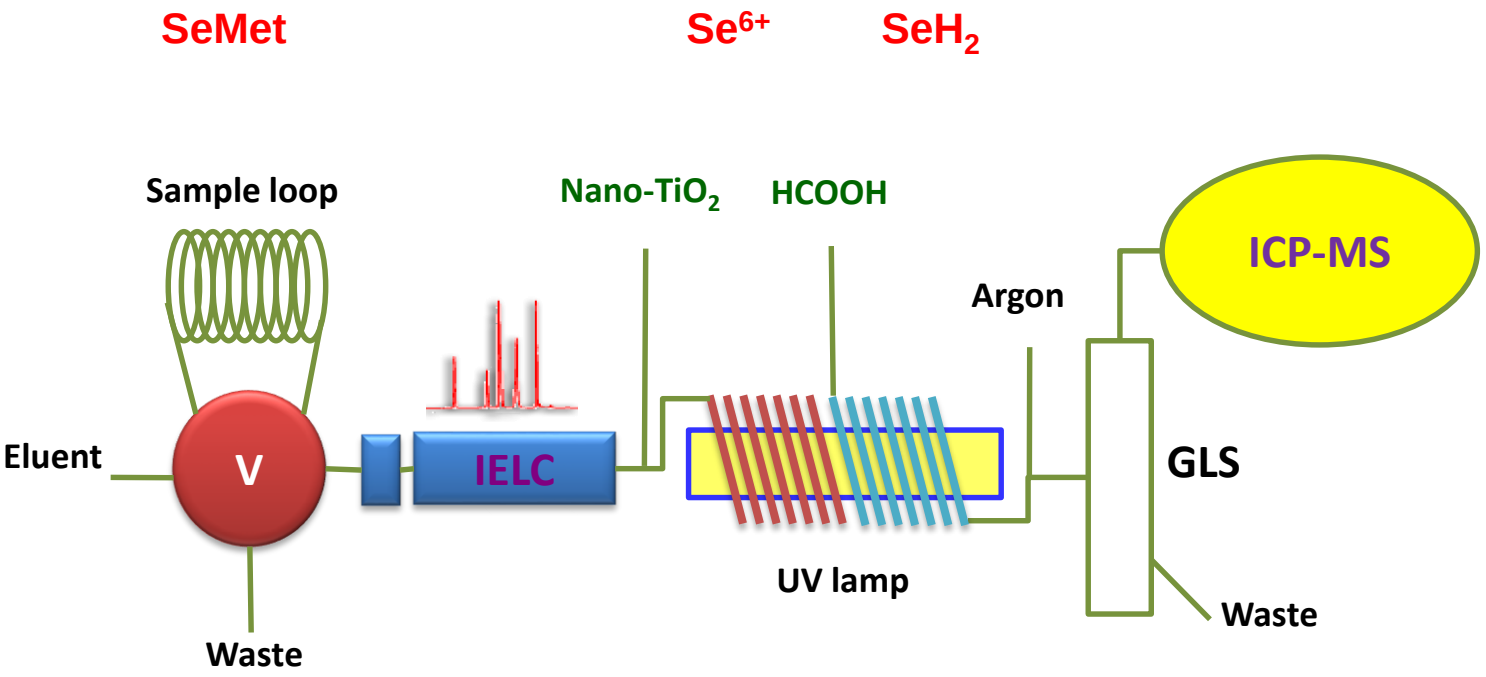
Separation → **Interfacing** → **Detection**



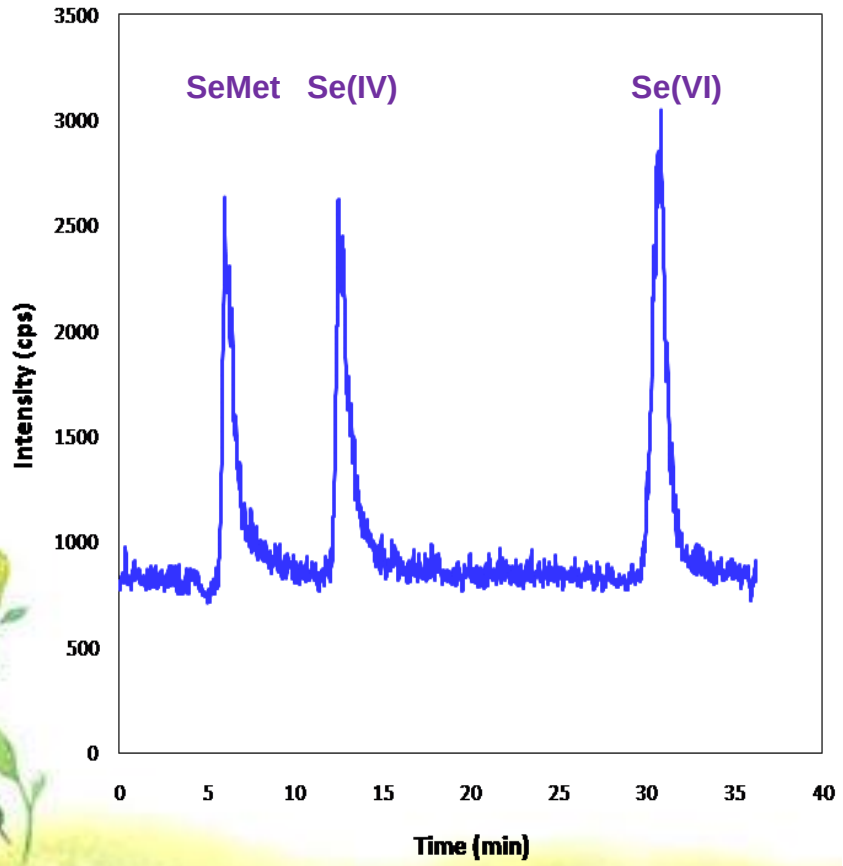
Nanocatalyst-assisted Vaporization and Digestion

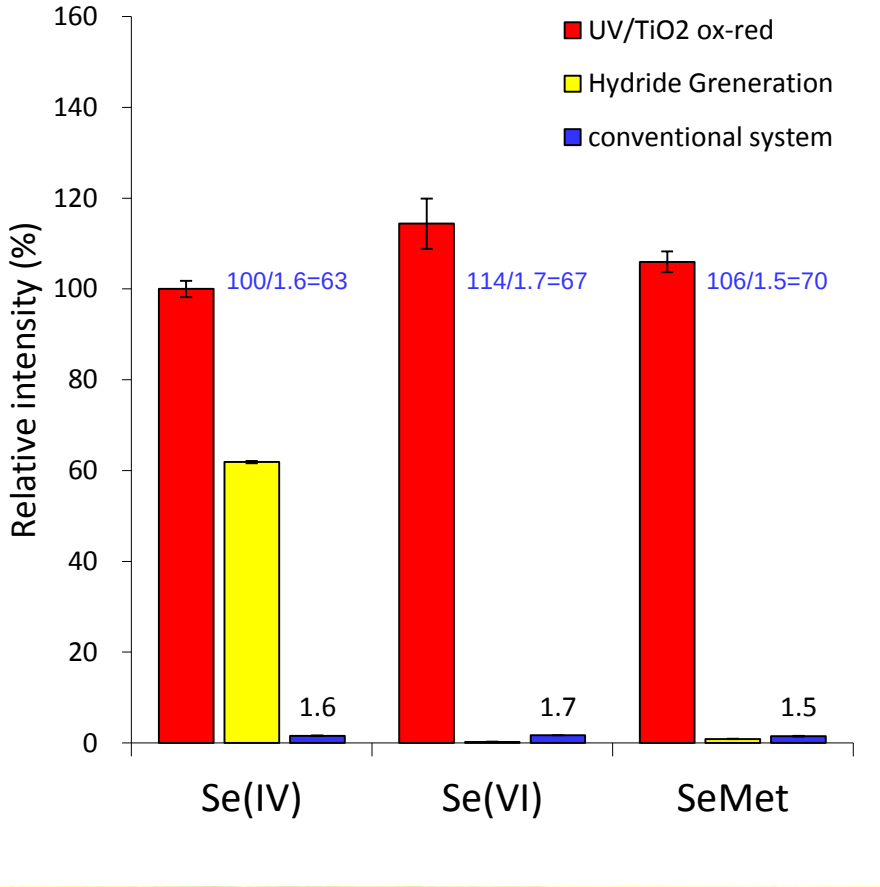


HPLC-UV/TiO_2-HG-ICP-MS On-line System

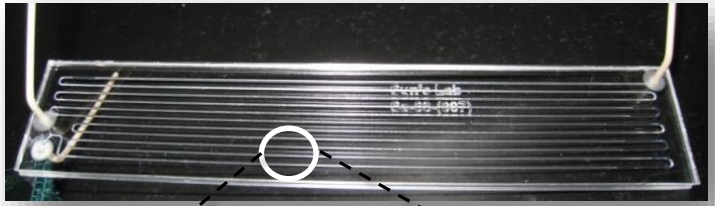


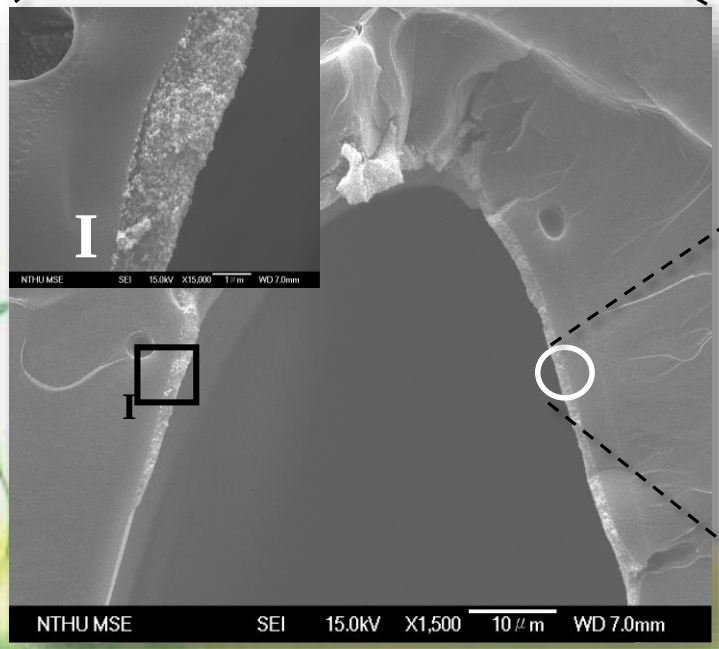
Analytical Sensitivity of Different Methods

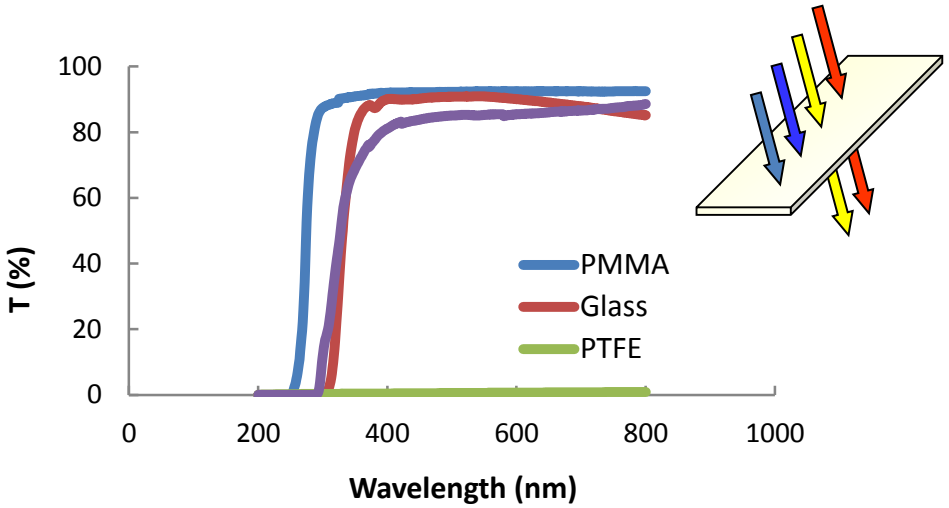


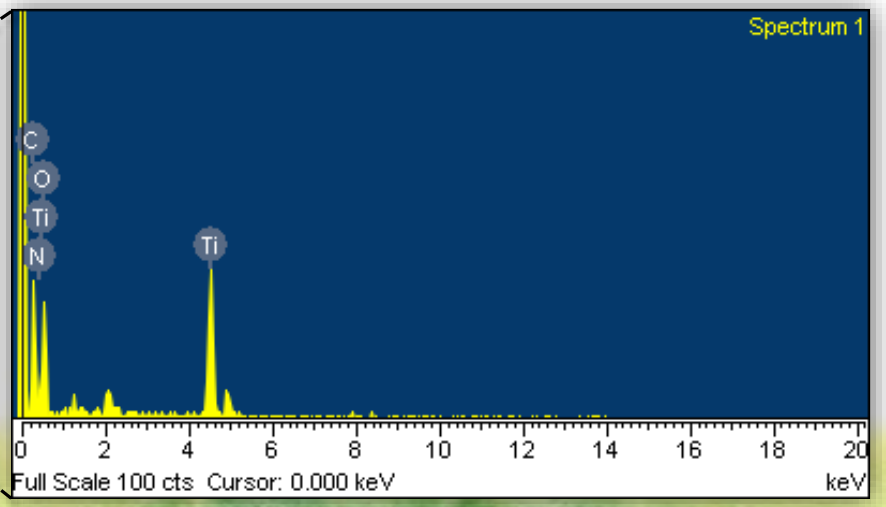


HPLC-Chip-Based Immobilized Nano-TiO_2 Photocatalytic Reduction Device-ICP-MS System









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