New Vapor-MEES method:
System development and preliminary results

Roman Schutz, Hila Rubinstein, Elena Vervitski,
Valery Bulatov and Israel Schechter
Schulich Faculty of Chemistry, Technion – Israel Institute of Technology

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Israel Institute
of Technology

What is Multiphoton Electron Extraction Spectroscopy (MEES)?

Irradiation of many materials by short UV laser pulses almost always results in a certain level of ionization, regardless of the laser wavelength.

MEES is an analytical method that measures the photo-electrons produced due to a multiphoton process, to give a photo-charge versus laser wavelength.
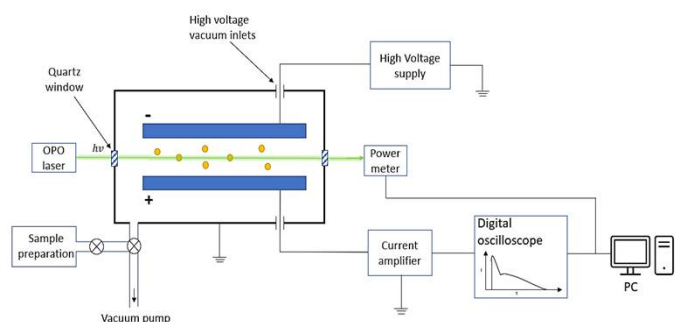
The method is very sensitive, and many peaks can be observed at wavelengths that are in resonance with energy levels of the vapor/gas molecules of various aromatic compounds, compounds containing a nitro group, and polyaromatics. For example, it was detected up to a few ppb of toluene in air by this new experiment.

The measurements can be carried under ambient conditions: room temperature, 60-80% humidity, and ambient pressure.

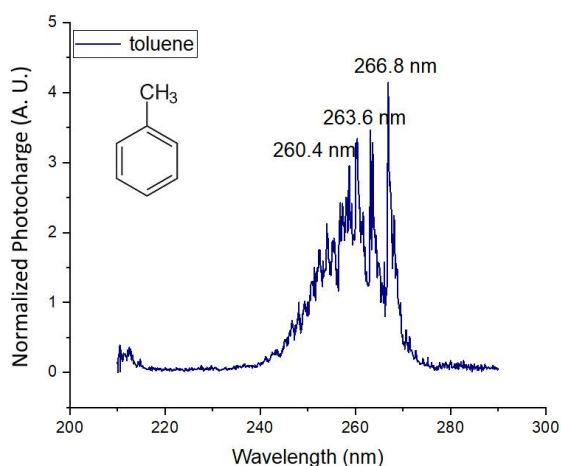## Block diagram of Vapor-MEES system

Experimental set-up

- In this study, a spectroscopic analysis of vapors of organic substances in a special hermetic chamber, with the possibility of creating a vacuum, is carried out.
- In the chamber, two electrodes 22 cm long are positioned 1-2 cm apart. A high voltage supply is connected to one of the electrodes and can provide up to 5 kV/cm electric field. The second electrode is connected to a current amplifier.
- The measurements are carried out in the ultraviolet region of the spectrum using a solid-state OPO pulsed laser.
- Gas samples are introduced to the chamber through a valve or a rubber septa. In addition, nitrogen gas of high-grade purity (99.999%) can also be introduced to fill the volume of the chamber.
- Vapor molecules ionized by the beam produce photo-charges (electrons and ions) that reach the electrodes and create a photocurrent.
- The waveform of the photocurrent is recorded by the oscilloscope for each wavelength over time. The recorded waveforms are transferred to a computer, where they are integrated to obtain the total photo charge as a function of wavelength.
- The power meter data is also recorded on the computer and allows normalization of this data to the beam energy.
- The software complex for the experiment is being developed using VB.NET code. The setup operation and data analysis were automated, such that the MEES spectrum of the gases in the measurement chamber can be obtained.
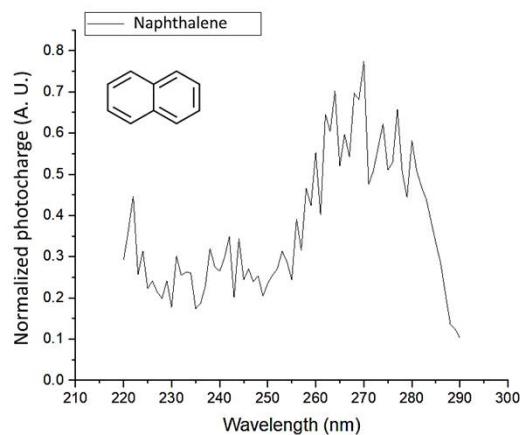
Results: Toluene vapors

Vapor-MEES spectrum of toluene in nitrogen atmosphere (concentration is about 1 ppm).

Results: Naphthalene vapors

Vapor-MEES spectrum of naphthalene in air atmosphere (concentration is about 240 ppm).