

# Group Electromagnetic Sensors

## **Investigating solids, liquids and gases by Surface Photo- Charge Effect (SPCE)**

**The effect: the interaction of any solid with electromagnetic field induces an electric, alternating potential difference with the same frequency as the frequency of the incident field.** Experimentally, the potential difference between the irradiated sample and the common electric ground of the system was measured. The measurement is contactless and fast. An important feature of the SPCE is its significant dependence on the specific properties of the irradiated sample. This fact reveals vast opportunities for rapid and contactless analysis of solids, liquids and gases. In contrast to other similar effects, the SPCE is characteristic of all kinds of solids and this makes it very interesting from scientific as well as from practical point of view. The applications experimentally tested by us are:

- ▶By this method one can obtain valuable information about the irradiated solid surfaces, namely about the presence of mechanical defects and imperfections, impurities and surface states, surface electrical characteristics such as a type of conductivity, etc. One can trace the shape of the produced surface structures, for example, by ion implantation.
- ▶Contactless characterization of semiconductors.
- ▶Remote retrieval of information on a solid object and its displacement.
- ▶ The temperature dependence of a sample.
- ▶Another field of applications is the gas, vapor and liquid sensors development on the basis of SPCE. The method provides information on fluids and processes taking place therein. For example, it is possible to monitor the octane factor of gasoline, impurities in liquids, the concentration of gases.
- ▶Construct a level-meter indicating the level of a liquid without moving parts.
- ▶Our experiments showed that one can monitor the deposition of materials from solution. For example, such a change was observed when  $\text{CaCO}_3$  was deposited on a metal surface from water.
- ▶Up to now we have showed experimentally that it is possible to make express contactless chemical composition test of samples, for example counterfeit coins - the detector could be designed relatively economically and small in size, so as to be installed in any coin-operated

machine. In addition to the protection of the national currency, the SPCE may find many other applications. For example, various types of absorbing filters for gases and liquids can be monitored to determine when they need to be replaced. Test of drinking water from the public water distribution system or that distributed to an army in field operations is technically feasible. Very often when making special details in industry, it is important to know if there are changes in the chemical composition of the material from which they are being made. At present such control on every separate detail is not usually done. The offered method can also be applied to such purposes.

►The above effect can be applied for registration of specific reactions and processes taking place in milk. We propose a technique for instantaneous detection of inhibitors (antibiotics) in milk. We suggest possible methods for quality control of milk and other foods.

►The possibility of monitoring the quality, of raw materials in particular for the manufacture of ceramic products and especially for bricks has been investigated. This monitoring solves technological, environmental and energy saving problems. The obtained results indicate the possibility of control of incoming raw materials and other industrial processes

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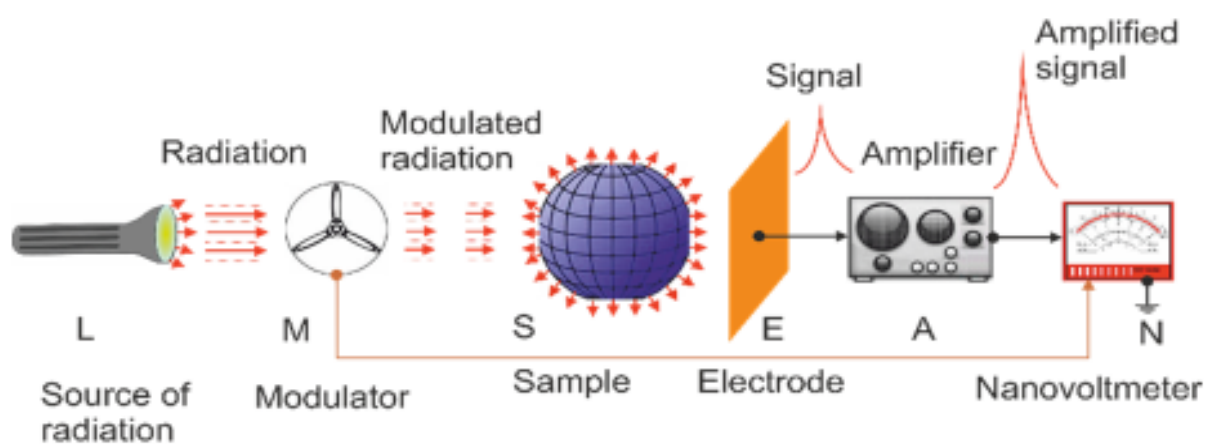
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# Experimental scheme

Experimental setup for SPCE observation




*L - light source; M - opto-mechanical modulator; S - measuring structure; E – electrode; A - high impedance amplifier; N - lock-in nanovoltmeter;*

# Research and development



August 7<sup>th</sup>, 2003

Today, August 7<sup>th</sup> 2003, at the Institute of Solid State Physics, Bulgarian Academy of Sciences, a newly created device for detection of counterfeit coins, based on irradiation with electro-magnetic field, was demonstrated. The demonstration was carried out in the presence of both Mrs. Ines Lazarova - Expert in commemorative and circulating coins, Bulgarian National Bank and Mrs. Petya Krasteva - Expert, Bulgarian National Bank. Bulgarian coins with a face value of 50 st. were tested. Several series, consisting of 10 to 15 coins were measured. Each of the above series contained arbitrary, unknown to the demonstrator, number of genuine and fake pieces. The results of the tests revealed 100 % identification of the counterfeits. The experts pointed out that the tested system was not ready for commercial applications, but the demonstration showed the possibility to create a device, based on this principle. Some suggestions, regarding the measurement procedures and the design were also made.

Demonstrator:   
/Assoc. Prof. Ognyan Ivanov, PhD/

Experts: 1.    
/Mrs. Ines Lazarova, Bulgarian National Bank/  
2.   
/Mrs. Petya Krasteva, Bulgarian National Bank/

*Way to the 21<sup>st</sup> Century*

**EAST-WEST EURO INTELLECT - BULGARIA**

**Exhibition for transfer of intellectual products and selling of goods**

# Diploma

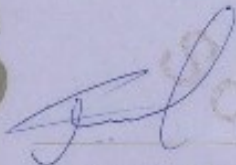
**GOLD MEDAL**

presented to

**Ognyan Ivanov**

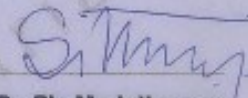
in recognition of the display of

**LEVEL METER FOR LIQUIDS**



**Chairman of the  
International Jury**

EWEI - SOFIA - 2005



**Dr. Sla Mednikarova**  
*President of "EWEI" and  
the Exhibition Committee*

## Report

On 01.08.2005 a demonstration was made of operative model of a fuel level-meter, developed by Assoc. Prof. Ognyan Ivanov, PhD. Volodia Naydenov, representative of the firm Inergy Automotive Systems (Belgium) was present at the demonstration.

The device was ascertained to be working in conformity with the requirements. An agreement was achieved that it is necessary to continue the research in order to create new models and prototypes of fuel level-meters with definite parameters.



**Attended the demonstration:**

*/ Dr. Eng. V. Naydenov /*



**СЪЮЗ на ИЗОБРЕТАТЕЛИТЕ в БЪЛГАРИЯ**  
**ДИПЛОМ**

издава се на

**Огнян Иванов и Живко Стоянов**

за присъждане на «Почетен медал» за успешно представяне на разработката  
«Сензор за качествен контрол на входящи суровини»

в четвъртото

**ИЗЛОЖЕНИЕ**  
**ИЗОБРЕТЕНИЯ \* ТЕХНОЛОГИИ \* ИНОВАЦИИ**  
**ИТИ'2012**

София, 08–10.11.2012 г.

Марко Христов  
Председател



09.11.2012г.

# Project COUNTERFOG



## COUNTERFOG



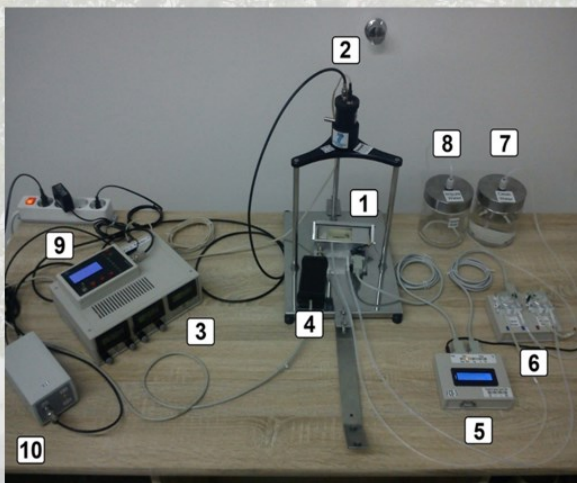
### DEVICE FOR LARGE SCALE FOG DECONTAMINATION

**Objectives:** The project aims at establishing systems for coverage of terrorist attacks with weapons of mass destruction - chemical, biological and radioactive. The task of ISSP is to develop sensors and devices, by means of which to operate these systems. For this purpose, we are working on a series of devices with different functions.

#### Working principles:

Created working devices, mainly based on original results obtained in ISSP, merged under the name Surface Photo-Charge Effect (SPCE) - the interaction of any solid with electromagnetic field induces an electric, alternating potential difference with the same frequency as the frequency of the incident field. The measurement is contactless and fast. An important feature of the SPCE is its significant dependence on the specific properties of the irradiated sample. This fact reveals vast opportunities for rapid and contactless analysis of solids, liquids and gases.

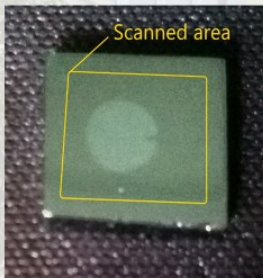
- System designed for evaluation of fog contamination and detection of dispersed agents.



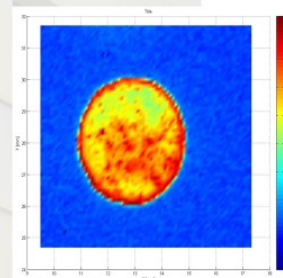
#### Examples of devices created by the project:

##### - A scanning system for sensitive specimens used in sensors

It is very important to choose correctly the exact point in which the laser beam illuminates the solid - fluid interface of the sensor. This choice defines the sensitivity of the sensor to fog influence. Due to the aforementioned reasons we initiated the creation of a system for automated scanning of wafer specimens. It finds SPCE-sensitive spots on various solid surfaces.



The specimen being scanned



Proof of concept scan over a known ion implanted area of a specimen

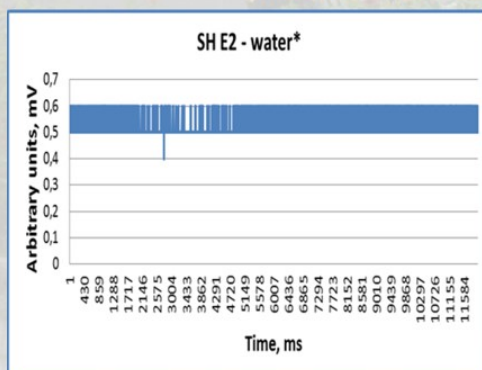
##### - Apparatus for controlling the movement of fluids



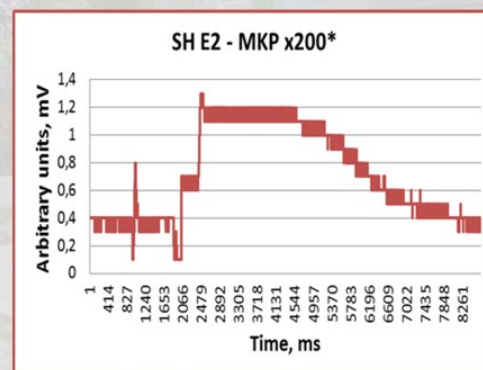
##### - Device for records and visualises the maximum signal amplitude (and respectively fog intensity) reached during a period of time.



### Results of measurement of clean and polluted fog



Pure fog



Fog with contaminator - concentration 0.14 M