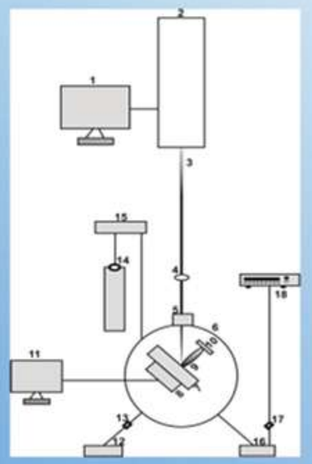
Obtaining procedure of SnO_2 photoelectrodes using picosecond laser with dye sensitized solar cells applications

NATIONAL INSTITUTE FOR LASER, PLASMA AND RADIATION PHYSICS

National PATENT APPLICATION A100226/06.05.2021
Inventors: Cornelia Enache, Cristian Viespe

ABSTRACT: The invention refers to one procedure of obtaining in situ of SnO_2 photoelectrodes (nanoporous films) using a picosecond laser by laser ablation method with DSSC (dye sensitized solar cells) applications. This type of photoelectrodes (SnO2) have the advantage of high electrons mobility, high absorption in red-IR domain, larger band gap. Nanoporous SnO_2 films obtained in situ meet the requirements of a photoelectrode from morphological point of view, in terms of adhesion and composition, for obtaining DSSC.

CLAIMS: Obtaining procedure of SnO_2 photoelectrodes by laser ablation using picosecond laser characterized by the fact that we obtained in situ nanoporous films that meet the requirements of a photoelectrode in terms of morphology, adhesion, composition for dye sensitized solar cells (DSSC) applications.



A laser beam (3) emitted by a ps laser (2) computer controlled (1) is focused on the focus lens (4) and then passes through the window (5) placed at the entrance of the deposition chamber (6) and focused onto the target (7) (tin metal). Following the interaction of the laser beam (3) – target (7) an ablation plum (9) is formed which is deposited onto FTO (fluorine doped tin oxide) substrate (10). During the deposition process, the target is moved by a motorized X-Y translation system (8) computer controlled (15). Before deposition, the deposition chamber (6) is evacuated by a high vacuum turbomolecular pump (12); during the deposition in the chamber is introduced gas from the gas cylinder (14) with a constant flow controlled by a system (15). The desired working pressure is maintained in the deposition chamber (6) by a valve (17) controlled by a controller (18) connected to a preliminary vacuum pump (16). After deposition, the films were treated in oxygen atmosphere in an oven connected to the gas cylinder.

ACKNOWLEDGMENTS: THIS WORK WAS SUPPORTED BY A GRANT OF THE ROMANIAN MINISTRY OF RESEARCH AND INNOVATION, CCCDI-UEFISCDI PROJECT NUCLEU contact: NILPRP, Laser Department, Quantum Dots, Nanopowders and Thin Films Group, http://qdntf.inflpr.ro/
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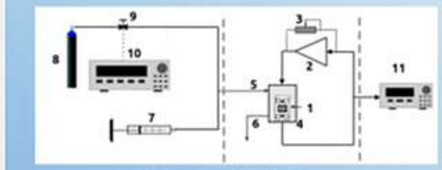
Discriminative detection method of analytes using surface acoustic wave sensors in a tunable oscillatory circuit.

NATIONAL INSTITUTE FOR LASER, PLASMA AND RADIATION PHYSICS

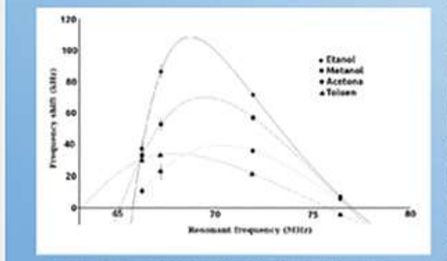
National PATENT APPLICATION A00337/15-06-2021
Inventors: Nicolae Ionut, Marcu Aurelian, Viespe Cristian, Miu Dana

ABSTRACT: The invention refers to a method of analytes discrimination based on the frequency deviation measurement of a tunable oscillatory circuit, having a surface acoustic wave sensor (SAW) connected in its positive reaction loop. The fundamental operating frequency is controlled by adjusting the value of an adjustable resistance placed within the oscillator amplifier feedback loop. The control of the gas composition in the SAW sensor chamber is achieved by introducing a known quantity of the analyte in a synthetic air atmosphere. Thus, in the presence of an analyte, the oscillator circuit frequency will change from its fundamental frequency, depending on the quantity and type of the analyte, but also depending on the chosen fundamental frequency of oscillation.

CLAIMS: The analyte discrimination method, it discriminates between analytes using the same type of sensor, without the need to use specific (different) sensors for each individual analyte.Mmethod is based on surface acoustic wave sensors (SAW) frequency deviation, in the presence of analytes, is measured at several fundamental (free) oscillation frequencies.



SAW sensor experimental setup



Frequency shift variation on circuit base (free) oscillation frequency

Operation:
Surface acoustic wave sensor (1) is connected in the loop of an oscillator formed by the amplifier (2) with adjustable resistance (3) in the reaction loop that oscillates in the band of tens-hundreds of megahertz and phisically placed in a monitored enclosure (4), The control of the composition of the gas in the premises is achieved by introducing a known quantity of the analyte through the entrance (5) into the controlled premises (4), the ventilation of the premises being carried out through the exit (6). In the case of the above example, ethanol, methanol, acetone or toluene are used, introduced with the help of a syringe (7) mixed with synthetic air (8) in a percentage controlled by a gas valve (9) by a gas controller (10) . The control of the fundamental oscillation frequency of the circuit is achieved by adjusting the value of an adjustable resistance (3); The working frequency is monitored with a frequency analyzer (11), and the frequency deviation of the sensor in the presence of the analyte is determined by comparing the frequency obtained with the SAW sensor in synthetic air (in the absence of the analyte) with the one in the presence of the analyte (gas) introduced.

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Enhancing the Antitumoral Effect of Chlorpromazine through Laser Irradiation

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Technical Field

The **OSIM Patent Application no A/00409/ 22.08.2024** falls under A61P - SPECIFIC THERAPEUTIC ACTIVITY OF CHEMICAL COMPOUNDS OR MEDICINAL PREPARATIONS (35/36 Antineoplasic agents).

Problem Addressed

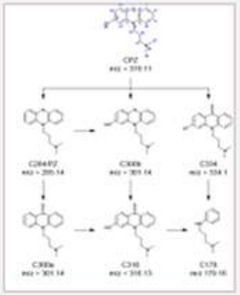
Current cancer therapies face challenges like drug resistance and high toxicity to healthy cells. This method offers a selective approach to reduce side effects and improve treatment outcomes.

Technical Solution

This invention proposes a targeted cancer therapy using chlorpromazine (CPZ), a phenothiazine-class drug, activated by 266 nm Nd:YAG laser irradiation. Post-irradiation changes were analysed via UV-Vis, FTIR, and HPLC-MS to identify photoproducts.

Molecular docking predicted interactions with cancer-specific targets. In vitro testing (MTS, Live/Dead, LDH) confirmed the potential of laser-activated CPZ as a selective anticancer agent.

Laser irradiation transforms CPZ into photoproducts that show strong interaction with cancer-specific targets (aromatase and egfr). These compounds demonstrated selective cytotoxicity in vitro.



Advantages

- Higher selectivity for cancer cells
- Lower effective drug doses
- Reduced side effects
- Potential to overcome drug resistance
- Utilizes an existing, well studied drug
- Cost-effective and scalable for clinical use

KEY FINDINGS

Laser irradiation initiates the formation of photoproducts, and the duration of irradiation affects the appearance of specific photoproducts.

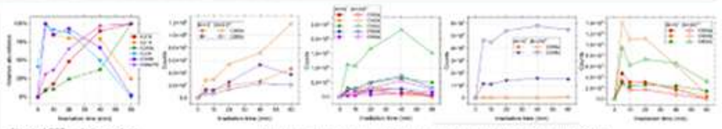
Moreover, the HPLC-MS analysis show formation of several photoproduct dimers (C6S0a6c, C6H5ab C5S2abcde, C5H6ab).

Although CPZ and the monomeric photoproducts show low predicted binding energies, the dimeric compounds exhibit even lower binding affinities, with C6S0b showing the most favorable interaction energy (-11.31 kcal/mol).

CPZ's toxicity depended on the duration of irradiation and treatment dose, with the most significant effect after 40 min of irradiation.

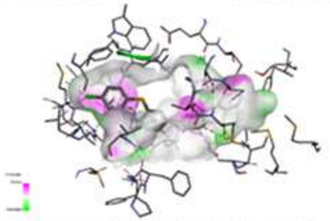
Irradiated CPZ induced cell death in both cell types, with a more pronounced effect in tumour cells, indicating possible selectivity for cancer cells over normal cells. Irradiated CPZ caused membrane disruption and significant F-actin cytoskeleton changes [1].

[1] Udrea, A.M., Staicu, A., Smarandache, A. et al. Enhancement of chlorpromazine efficacy in breast cancer treatment by 266 nm laser irradiation. Sci Rep 14, 30329 (2024).

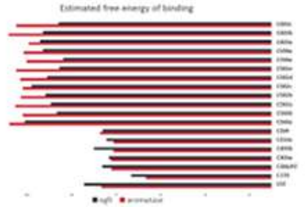


Abund. of CPZ irradiation products

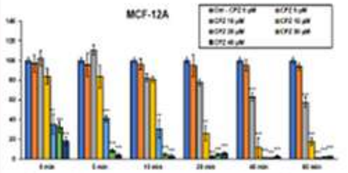
Abundance of high mz photoproducts of chlorpromazine irradiation over the course of 60 min.

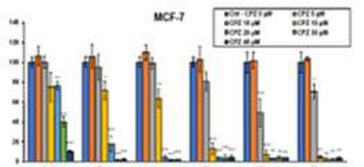


3D interaction of prochlorperazine (C6H4F2) with the estrogen receptor in the run with the lowest EFEB

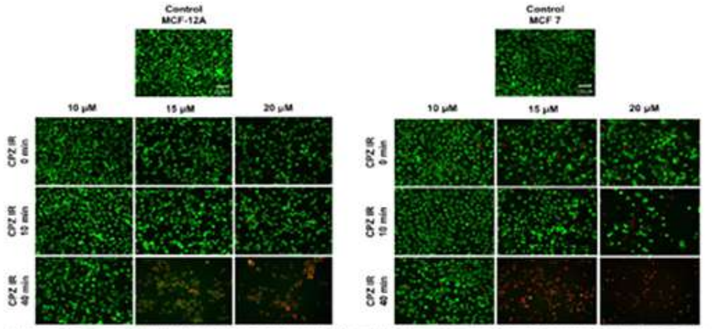


Biological targets and the lowest CFEB for CPZ and its photoproducts, predicted using Autodock software.

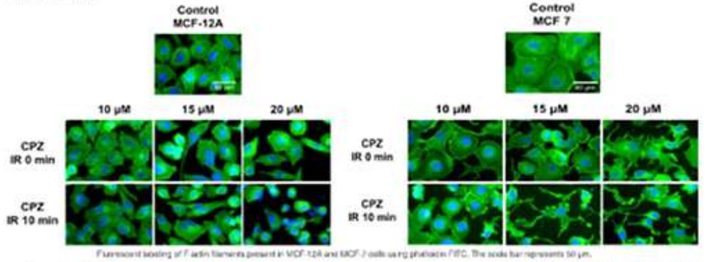




Cellular viability levels were assessed, and significant results were indicated by error bars representing standard deviation with p≤0.5(*), p≤0.01(**), p≤0.001(***).



Fluorescence microscopy images showing MCF-12A and MCF-7 cells. Viability of cells is marked with green fluorescence, while dead cells are marked with red fluorescence. The scale bar represents 100 µm.



Fluorescent labeling of F-actin filaments present in MCF-12A and MCF-7 cells using phalloidin-FITC. The scale bar represents 50 µm.

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