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## Enhanced near-infrared plasmonic sensing chips with ultra-thin optical absorption nanolayer fabricated by cross-beam pulsed laser deposition (CB-PLD)

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- Title:

Enhanced Near-infrared Plasmonic Sensing Chips with Ultra-thin Optical Absorption Nanolayer fabricated by Crossbeam Pulsed Laser Deposition (CB-PLD).

- Author(s) information:

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- Speaker biography (1000-character max including spaces)

Speaker biography: Nurzad Zakirov is currently doing a double-degree PhD thesis at the Institut National de la Recherche Scientifique (Laboratory of Micro and Nanofabrication (LMN), Canada) and the University of Technology of Troyes (Light, Nanomaterials and Nanotechnologies (L2n), France). Nurzad received his master's degree with a major in Nanophotonics from the University of Technology of Troyes in France. He completed his bachelor's degree in condensed matter physics at the National University of Science and Technology MISIS in 2021. The focus of his research is the fabrication of a novel SPR-based biosensing devices with enhanced sensitivity using nanomaterials.

- Abstract for technical review:

Plasmonic biosensing is a trending technique for real-time monitoring the interaction of molecules through the refractive index change upon sensing surface. This work is dedicated to develop a smart SPR sensing chip consists of a temperature tunable VO<sub>2</sub> layer sandwiched between a gold layer and quartz substrate. Herein, to obtain the precise control of thickness and the phase transition point of the VO<sub>2</sub> layer, we adopted the crossbeam pulsed laser deposition (CB-PLD). Such tunable VO<sub>2</sub> nanolayer was fabricated by using 3J/cm<sup>2</sup> laser pulses to hit the vanadium target in 8 mTorr oxygen and 32 mTorr Argon atmosphere. The pulsed deposition manner allows the precise tuning of nanolayer thickness that has a resolution of 1.2 nm per 1000 pulse. Besides, the crossbeam configuration allows a higher film uniformity due to the reduction of large microparticle formation in nano-film deposition. Moreover, One can achieve the phase transition of VO<sub>2</sub> layer at 40 degrees through the employment of doped vanadium metallic target in CB-PLD at which the DNA molecules can be still stable and remain as pairs. Thus, the sensing substrate allows the tunable measurements at a moderate temperature without affecting the interactions between the biological molecules.

In order to obtain the optimized parameters for VO<sub>2</sub>-based sensing substrate, we have simulated the plasmonic resonance curves based on transfer matrix method and Fresnel equations. Since the change of VO<sub>2</sub> absorption coefficient during its phase transition in the near-infrared region (NIR) is larger than that in visible light, which allows better tunability, here we used a laser with an emission wavelength at 966 nm to excite the plasmonic resonance with a prism-coupled Kretschmann configuration. We have fabricated the sensing substrate with different VO<sub>2</sub> nanolayer (with thickness ranging from 5 nm to 25 nm with a step of 2 nm) deposited by CB-PLD and gold by sputtering (with a thickness ranging from 35 nm to 50 nm). The highest plasmonic sensitivity was obtained with 10 nm VO<sub>2</sub> nanolayer and 47 nm gold as a top layer. Surface plasmon resonance curves were measured based on a Metricon Model

2010/M Prism Coupler by using glycerin solutions with fixed refractive-index change as calibration samples. The obtained optical signal is 20 times improved compared to the substrate without VO<sub>2</sub> layers and 10 times larger compared to other samples with different VO<sub>2</sub> thickness. In this presentation, we will delve into the fundamental principles, fabrication methods, and experimental results of our biosensor's performance. We will also explore its potential in healthcare and biotechnology.

- Summary of abstract for display in the program:

Plasmonic biosensing is an optical technique that based on refractive index change when the target molecules interact with the sensing surface. Main plasmonic material used in this type of biosensors is gold. Our work is dedicated to design a novel sensing SPR chip with vanadium dioxide (VO<sub>2</sub>) nanolayer, known for its unique insulator-to-metal phase transition in the near-infrared region. VO<sub>2</sub> thin film is deposited using Cross-Beam Pulsed Laser Deposition (CB-PLD) method and gold layer deposition is performed by sputtering. By employing the VO<sub>2</sub> nanolayer, we create a highly responsive biosensing interface (with a much-improved sensitivity and also a wide dynamic measurement range). The VO<sub>2</sub> layer's ability to modulate the refractive index enables precise control of the excited plasmon resonance. This interaction results in enhancing sensitivity and the capability to detect low-concentration analytes with high accuracy.

- Keywords used in search for your paper (optional):

Plasmonic Biosensor, Nanomaterials, Vanadium Dioxide, Biomedical Sensing