

University of Alabama in Huntsville

**LOUIS**

---

Summer Community of Scholars (RCEU and  
HCR) Project Proposals

Faculty Scholarship

---

1-1-2015

## **Compact and low-cost Optical Fiber LSPR Probe for Early Cancer Detection**

Yongbin Lin

*University of Alabama in Huntsville*

Follow this and additional works at: <https://louis.uah.edu/rceu-proposals>

---

### **Recommended Citation**

Lin, Yongbin, "Compact and low-cost Optical Fiber LSPR Probe for Early Cancer Detection" (2015).  
*Summer Community of Scholars (RCEU and HCR) Project Proposals*. 348.  
<https://louis.uah.edu/rceu-proposals/348>

This Proposal is brought to you for free and open access by the Faculty Scholarship at LOUIS. It has been accepted for inclusion in Summer Community of Scholars (RCEU and HCR) Project Proposals by an authorized administrator of LOUIS.

## Compact and low-cost Optical Fiber LSPR Probe for Early Cancer Detection

### Faculty or Research Mentor:

Dr. Yongbin Lin, Research Scientist.

Center for Applied Optics (CAO) and Nano and Micro Device Center (NMDC)

438 Optics building, UAH, Huntsville, AL35899

Ph: (256) 824-2515 Fax: (256) 824-6618

Email: liny@uah.edu

**Project Summary:** For many years, cancer has been diagnosed and treated after the cancer cells have already invaded surrounding tissues and metastasized throughout the body, resulting in low survival rates. Early detection is the key to cancer survival. Biomarkers of cancers have been found to be very important tools for cancer detection and monitoring, because they serve as hallmarks for the physiological status of a cell at a given time and change during the disease process.

The main aim of this research project is to develop and validate a compact, low-cost, label-free, high-sensitivity, robust localized surface plasmon resonance fiber-optic biosensor (LSPR-FO) probes [1, 2]. These probes will be used as point-of-care (POC) devices to measure the cancer molecular biomarkers which can be utilized for early detection/diagnosis of cancer, monitor the therapy response or predict the clinical outcomes. Successful development of this project will result in a handheld, low-cost integrated device that enables the extremely early detection of cancers and diseases, even while it is at the small cluster of cancer cells level. At this stage the cancer is much easier to treat. We are submitting grant applications with our collaborator Dr. Jianjun Wei, an associate professor at the JSNN, to the National Institutes of Health to fund our future biosensing testing, validation and integration work. The fiber probe LSPR biosensor can be packaging into a lunchbox-size unit that ultimately may use a cellphone app to provide test results.

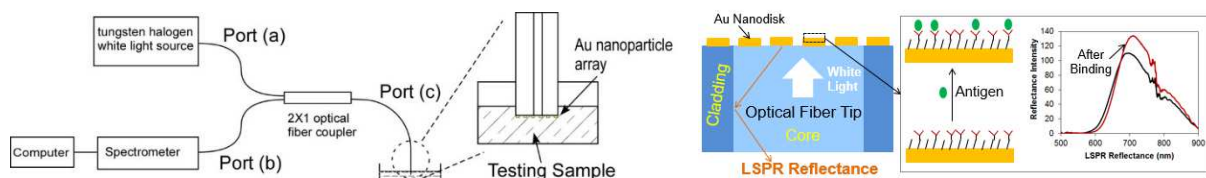


Figure 1. (left) Optical scheme for LSPR-FO nanoprobe testing and spectral measurements. (right) Immunoassay for biomarkers detection principle and a direct antibody-antigen interaction

As part of the major research project, this RCEU 2015 summer project is focus on the testing and validation of fiber LSPR biosensor dip probe with various cancer biomarkers, such as Interleukin 6 (IL-6), Interleukin 8 (IL-8), and Prostate-specific antigen (PSA). For example, a lot of cancers have links to the increase of IL-6 level in the bloodstream, which is secreted by the body's T-cells and macrophages to stimulate inflammatory and immune responses. We have successfully applied a simple and effective method for IL-6 detection, as illustrated in Fig.1, and it will be extended to other antigen biomarkers. Details of the surface functionalization on the fiber end gold nanodisks with antibody (anti-IL-6) and monitoring can be found in ref [3, 4].

Once the antibodies (mAbs, anti-IL-6) have been immobilized on the gold nanodisk fiber tip surface, the sensor is ready for detection of IL-6. In order to test binding of IL-6 to the anti-IL-6 mAb modified

surfaces, 9 tenfold dilutions of a 1 $\mu$ M concentration of IL-6 were prepared in PBS solution. The sensor tip will be placed in the IL-6 PBS for 10 minutes in the sequence from the lowest concentration of 10<sup>-14</sup> M (10fM) to 10<sup>-6</sup>M (1 $\mu$ M) to measure the reflectance spectrum. After each measurement, the fiber tip is rinsed thoroughly with DI water, and dry in the air. All spectra are obtained after fiber tip is cleaned and dried in the air. Control experiments will be designed and carried out to evaluate the specificity/selectivity of the immunoassay using the LSPR-FO devices. Specifically, the binding between the detector mAb and bovine serum albumin (BSA) at concentrations of 5 mg/mL will be evaluated.

The localized surface plasmon resonance fiber-optic dip probe will be designed and fabricated by Dr. Yongbin Lin in the NMDC cleanroom Lab in the Optics Building in UAH. The undergraduate student will participate in testing the devices, collecting data to determine the bulk refractive index change sensitivity, the limit of detection (LOD) for sensing the antigen biomarkers, and the specificity of the detection, under the supervision of Dr. Lin.

**Student Duties:** The undergraduate student is expected to follow the general laboratory safety procedures and rules in the lab. The student is expected to have working skill (or training will be provided) for handling fiber optical devices and equipment, include optical fiber stripper, cleaver, and fusion splicer. The student will be expected to carry out biochemical binding procedures as detailed in the protocol using optical fiber LSPR nano-biosensor dip probes. The student will also collect experimental data and perform preliminary data process to show LSPR peak wavelength shifts for different concentrations of antigen biomarker (IL-6) in PBS buffer solutions. During the RCEU 2015 summer research, the participate undergraduate student will learn useful skills such as optical fiber manipulations, will expose to cutting edge nano biosensing devices, and most importantly, will be involved in the development of early cancer detection technologies. The student expects to spend 32 ~40 hours per week for 12 week period.

**Mentor Supervision and Interaction:** All research activities performed by undergraduate student in this RCEU 2015 proposal will be supervised directly by Dr. Lin, which includes optical fiber connection and setup, biochemical functionalizations, biomarker detection testing and data processes. Dr. Lin will meet and advise the student in the lab on a daily meeting each day. We will also hold a regular group meeting each week. The manuscript and poster preparation will also be supervised by Dr. Lin. After this RCEU 2015 summer program, we will submit a manuscript to a peer-review journal in the fall semester 2015, based on the data generated in the RCEU 2015 summer program.

## References:

1. Lin Y, Zou Y, Mo Y, Guo J, Lindquist RG: **E-beam patterned gold nanodot arrays on optical fiber tips for localized surface plasmon resonance biochemical sensing.** *Sensors* 2010, **10**(10):9397-9406.
2. Lin Y, Zou Y, Lindquist RG: **A reflection-based localized surface plasmon resonance fiber-optic probe for biochemical sensing.** *Biomed Opt Express* 2011, **2**(3):478-484.
3. Sanders M, Lin Y, Wei J, Bono T, Lindquist RG: **An enhanced LSPR fiber-optic nanoprobe for ultrasensitive detection of protein biomarkers.** *Biosensors and Bioelectronics* 2014, **61**(0):95-101.
4. Zhang T, He Y, Wei J, Que L: **Nanostructured optical microchips for cancer biomarker detection.** *Biosensors and Bioelectronics* 2012, **38**(1):382-388.