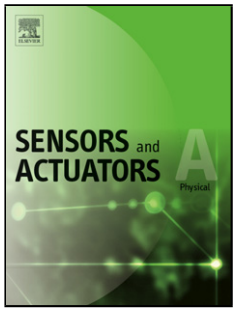

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Fabrication and measurement of microtip-array-based LSPR sensor using bundle fiber

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Highlights

- The novel fabrication process of the LSPR sensor using the microitp is proposed.
- The deposited gold is exposed using a self-aligned etching process at the tip end.
- The improved reproducibility in terms of fabrication and measurement is assessed.
- The optical system is based on bundle fiber which shows a simple optical setup.
- The LSPR signals varying refractive indices are measured to verify the feasibility.

Abstract

In this paper, we present a micro electro mechanical systems (MEMS)-technology-based localized surface plasmon resonance (LSPR) sensor using a uniformly distributed noble metal nanostructure array on a silicon microtip. The conventional LSPR sensor based on chemically synthesized metal nanoparticles exhibits a lack of reproducibility, which is caused by rearrangement and irregular sizes of metal nanoparticles. This problem strongly affects the LSPR sensing performance and reliability. To overcome this problem, we propose a novel fabrication process of the LSPR sensor using the microtip. The deposited gold is exposed using a self-aligned etching process at the tip end and it is used as gold nanoparticles. The whole process for the fabrication of the microtip is possible using a single photolithography mask. The detailed fabrication process is introduced and analyzed. In addition, the improved reproducibility in terms of fabrication and measurement of the fabricated sensor is assessed by reliability tests. Moreover, the LSPR signals with varying refractive indices of media are measured to verify the feasibility of the microtip-based LSPR sensor system.

Keywords

Bundle fiber; Localized surface plasmon resonance; Microtip; Self-alignment; Substrate assay

1. Introduction

Localized surface plasmon resonance (LSPR) is a phenomenon of collective oscillations by electrons in noble metal nanoparticles excited by external light [1, 2]. In general, the characteristic optical resonance wavelength is dependent on the material [3, 4], size [5, 6], and shape [7] of metal nanoparticles. Because the resonance depends on the dielectric constant of the medium, the refractive index change of the medium causes resonance shift, which can be used as a sensor by monitoring the resonance [8–10]. In previous research, LSPR sensors were generally fabricated by immobilizing metal nanoparticles on the surface of the substrate using metal colloid [11–14]. However, in that kind