*Optoelectronics and optoelectronic devices*

# Dust-insensitive smoke detector based on plasmon-polariton photodetector

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**Abstract.** In this study, a smoke detector based on plasmon-polariton photodetector (PPPD) is proposed to address the issue of false triggering in optical smoke detectors under conditions of high room dustiness. The proposed detector uses a PPPD based on a *p-n* junction in a silicon wafer, on which a metal grating is fabricated by interference photolithography technology for surface plasmon-polariton resonance excitation. The design of the smoke detector based on PPPD has been developed to enable the production of a relatively compact and inexpensive device. As a result of optimizing the PPPD parameters, the following characteristics of experimental samples with Au and Al gratings were achieved: the maximum polarization sensitivity $I_p/I_s$ ranging from 3 to 8, the spectral and angular half-widths of the photocurrent resonance range from 50 to 200 nm and from 5° to 10°, respectively, and photosensitivity at the resonance maximum $I_{ph}$ = 0.04...0.1 A/W.

**Keywords:** surface plasmon resonance, plasmon-polariton photodetectors, smoke detector.

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## 1. Introduction

Fire alarm systems typically incorporate various types of sensors due to the wide variety of fire types, flammable materials, and other conditions under which fires occur [1]. The most common devices for detecting smoke and warning of fire danger are smoke detectors of two types: ionization and optical [2]. However, these basic detectors have the drawback of falsely responding to aerosol or dust particles resulting from e.g. normal activity in a kitchen, bathroom, or construction site, rather than from an actual fire [3]. Several approaches are used to address this issue, which complicate the detector design: use of multiple wavelengths, multiple angles in detectors, and additional chemical sensors for combustion products, among which CO sensors [4] usually in the form of an electrochemical cell are particularly promising.

The sensors based on surface plasmon-polariton (SPP) resonance excitation may be also used to create smoke detectors [5, 6]. In particular, the reference [6] proposes a three-channel smoke detector, in which one of the channels' sensitive elements operates by exciting SPP resonance in a gold film in contact with the combustion products, using Kretschmann geometry with a glass coupling prism. An increase in carbon monoxide concentration changes the optical parameters of the medium, leading to an angular shift in the SPP resonance, which is detected as a change in the intensity of the light beam by an additional photodetector. At the same time, the angular and spectral position of the SPP resonance is relatively insensitive to ordinary dust, since due to the large size of the dust particles, they weakly adhere to the surface of the plasmon-active gold film and therefore cannot significantly change the parameters of the medium in the thin layer where the SPP wave propagates.

To simplify the design and enable miniaturization of such smoke detectors, this paper explores the potential of using a plasmon-polariton photodetector (PPPD) as a sensitive element in these devices [7]. To excite SPP in such photodetectors, a periodically textured surface (grating) with a thin layer of plasmonic metal (Au or Al) is employed. Previous works [8–10] optimized the parameters of PPPD based on gold and aluminum films to achieve maximum resonant photocurrent gain and, consequently, maximum sensitivity of sensors based on PPPD. This work builds upon those results by developing a smoke detector design, manufacturing experimental samples, and studying their parameters.

## 2. Experimental details

The sensitive element of the smoke detector under study is a PPPD based on a *p-n* junction in silicon. Therefore, *n*-Si (111) KEF-4.5 wafers with a *p-n* junction depth of 100...150 nm and rear ohmic Al contacts were used as the substrates for manufacturing the PPPDs. The necessary periodic relief structures (gratings) on the silicon surface were produced using interference photolithography with a vacuum chalcogenide photoresist (a detailed description of the production technology is presented in [10]). A feature of this technology is the profiling of exclusively the metallic plasmon-carrying film. This maintains a flat metal/semiconductor interface with low recombination of photogenerated carriers. Such PPPD has a simple construction and good resonant properties [8].

The grating surfaces were morphologically characterized using a Dimension 3000 Scanning Probe atomic force microscope (Digital Instruments Inc., Tonawanda, NY, USA) in the atomic force microscope (AFM) tapping mode. Optical constants of the thin gold and aluminum films deposited on Si substrates by vacuum thermal evaporation were measured in the spectral range of 250...2100 nm using a SE-2000 (Semilab Ltd.) spectroscopic ellipsometer. The spectral and angular dependences of short-circuit photocurrent $I_{ph}$ of the manufactured PPPD samples in the wavelength range of 400...1100 nm were also studied under illumination with *p*- and *s*-polarized light at the incidence angles $\theta = 0...70°$. The measuring setup included a tungsten lamp light source, light chopper, monochromator, Glan prism-type polarizer, photodetector with an amplifier, rotating sample holder, and controller computer [11].

Operation of the PPPD as a smoke sensor was tested on a specially designed stand, with a design based on the requirements of the UL 217 standard [12].

## 3. Design of a smoke detector based on PPPD

In the case of photoelectric registration of SPP resonances using a PPPD, SPP excitation will correspond to appearance of an additional maximum of $I_{ph}$ both in the angular and spectral dependences of the photocurrent. In both cases, the plane of incidence of the *p*-polarized light beam must be perpendicular to the grating grooves. This maximum is associated with the resonant increase in the concentration of photogenerated carriers due to the enhancement of the field strength of the plasmon-polariton wave near the *p-n* junction during SPP excitation. Accordingly, two methods can be used to design a smoke detector based on angular and spectral dependences of $I_{ph}$.

The operating principle of such smoke detectors can be understood by considering the effect of smoke on the corresponding PPPD characteristics. As an example, Figs 1a, 1b show the angular (at a wavelength of $\lambda = 650$ nm) and spectral (at an incidence angle of 6°) dependences of

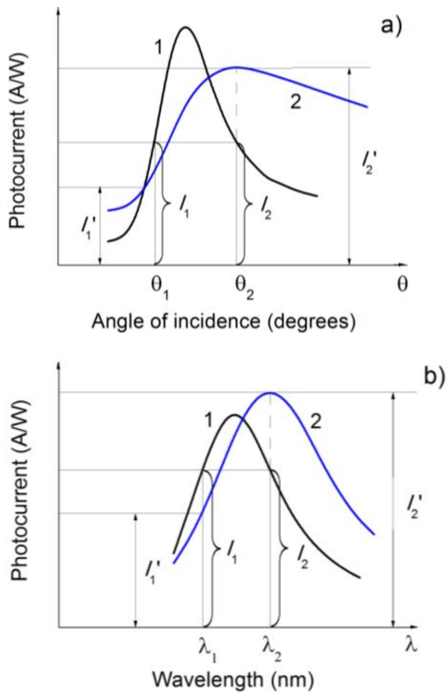


**Fig. 1.** Angular (a) and spectral (b) dependences of the PPPD photocurrent before (*1*) and after (*2*) contact with smoke under illumination with *p*-polarized light. The photocurrent value is normalized to the power of the incident radiation.

the photocurrent of a PPPD based on a gold grating with a period of 800 nm. These figures show a shift in the spectral and angular position of the plasmon-polariton excitation induced resonance in the photocurrent due to the deposition of smoke particles on the PPPD surface. Specifically, in this case, the angular shift of the SPP resonance is 5°, and the spectral shift is 27 nm. Such angular and spectral changes indicate the sensor sensitivity to smoke.

The design of the smoke detector based on angular dependence of $I_{ph}$ is shown in Fig. 2a. This detecting system contains two laser diodes (*1*, *2*) with the same radiation wavelengths and intensities, which alternately illuminate the PPPD. The angles of incidence of the radiation of the laser diodes *1* and *2* are different and correspond to the half-width positions of the maximum on the angular dependence of the PPPD photocurrent, *i.e.* $\theta_1 = 10°$ and $\theta_2 = 15°$ in Fig. 1a. The detector also includes an electronic part (*6*) containing a module for receiving and processing information based on a microcontroller. This module controls operation of the laser diodes and determines the ratio of the photocurrent values excited by the lasers. In the absence of smoke, these photocurrent values ($I_1$ and $I_2$) are equal and their ratio is one, as can be seen in Fig. 1a. When smoke particles are adsorbed on the PPPD surface, the angular position of the surface plasmon-polariton resonance is shifted. In this case, the photocurrent excited by the laser diode with the smaller angle of incidence ($\theta_1$ in Fig. 1a) is decreased, *i.e.* $I_1$ changes to $I_1'$. At the same time, the photocurrent excited by the second laser diode with the

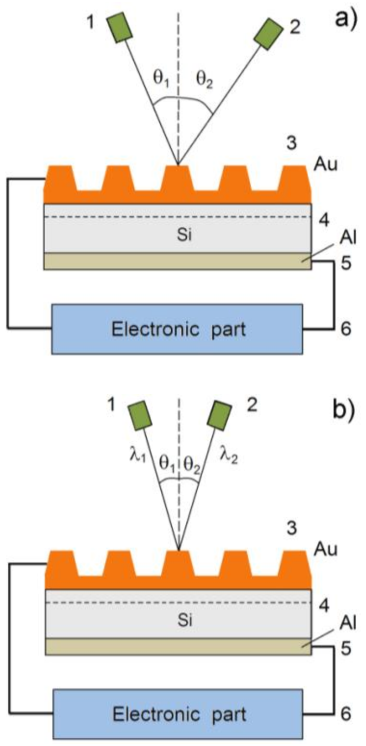


**Fig. 2.** Optoelectronic scheme of a smoke detector using a PPPD as a sensitive element based on angular (a) or spectral (b) dependences of photocurrent. *1*, *2* – laser diodes, *3* – a gold grating formed on the surface of a silicon wafer (*4*) with a shallow *p-n* junction (indicated by a dotted line), *5* – a rear aluminum contact, *6* – an electronic circuit for signal processing.

larger angle of incidence ($\theta_2$ in Fig. 1a) is increased, $I_2$ tends to $I_2'$. The ratio $I_2'/I_1'$ also is increased significantly, and once it reaches a critical value, the information processing module triggers an alert signal or a fire extinguishing system.

The second method of implementing the smoke detector design based on spectral dependences of photocurrent is illustrated in Fig. 2b. This detector contains two laser diodes (*1*, *2*) with slightly different radiation wavelengths (in this case, $\lambda_1$ = 700 nm and $\lambda_2$ = 760 nm), which alternately illuminate the PPPD. The angles of incidence of the radiation from both lasers are the same, and in this case $\theta_1 = \theta_2 = 6°$. The wavelengths of these lasers are chosen so that they correspond to the half-width of the maximum photocurrent of PPPD, *i.e.* $\lambda_1$ and $\lambda_2$ in Fig. 1b. This detector also has an electronic unit (*6*) with a module for receiving and processsing information, which controls operation of the laser diodes and determines the ratio of the values of photocurrent excited by the lasers. The operating principle of this version of smoke detector is similar to the first version, which is based on angular dependence of photocurrent: when submicron smoke particles are adsorbed on the PPPD surface, the ratio of the photocurrent values ($I_2'/I_1'$) is increased significantly, and once a critical value is reached, the information processing module triggers an alert signal or activates a fire extinguishing system.

## 4. Test results and discussion

To comprehensively test the sensitive elements of the developed smoke detectors, experimental batches of PPPDs, optimized by numerical simulations, were manufactured. In [10], the RCWA (Rigorous Coupled-Wave Analysis) method was used to numerically calculate the distribution of absorbed light energy in the PPPD layers and optimize the grating parameters. This made it possible to determine the PPPD parameters that provide maximum resonance values of the photocurrent. The studied samples (inset in Fig. 3a) included PPPDs based on gold and aluminum gratings with periods of 800 nm and 630 nm, respectively.

To evaluate the effect of dust on the developed smoke detectors, a sample of PPPD (based on a gold grating with a period of 800 nm) was placed in a closed sealed chamber with a volume of 0.1 $m^3$. According to the recommendations of the UL 217 standard [12], 60 g of cement powder was sprayed in the chamber to simulate dust. It was kept in a suspended state for 15 and 30 min using fans. Fig. 3 shows the angular and spectral dependences of the photocurrent of the studied PPPD before and after exposure to the dust in the chamber. It is evident that neither the spectral nor the angular position of the plasmon resonance of the photocurrent changed as a result of dust contamination. Only the amplitude decreased, which is a consequence of partial shading of the sensor element by the dust. However, the ratio of the photocurrent values from two laser diodes ($I_2'/I_1'$ in Fig. 1) remained equal to one, meaning that such a smoke detector will not react to dust accumulation on the sensitive element. A similar result was obtained for the PPPD sample based on an aluminum grating.

As shown in Fig. 3, the PPPD photocurrent exhibits a pronounced resonant character when irradiated with *p*-polarized light. The polarization sensitivity of PPPD is defined as the ratio of the photocurrent in resonance under *p*-polarization to the corresponding value under *s*-polarization, $I_p/I_s$. For the investigated PPPDs with optimized aluminum grating parameters, we obtained $I_p/I_s = 8$, the full width at half maximum of the photocurrent spectrum ranging from 50 to 100 nm, the sensitivity at the resonance maximum $I_{ph}$ = 0.04...0.06 A/W, and the angular half-width of the photocurrent resonance $\Delta\theta = 5°$. The obtained characteristics for the optimized PPPDs with gold gratings are as follows: the value of $I_p/I_s$ ranges from 3 to 5, $I_{ph}$ reaches 0.1 A/W, and the spectral and angular half-widths of the photocurrent resonance range from 100 to 200 nm and from 5° to 10°, respectively. Hence, both types of optimized PPPDs have comparable characteristics. These practical results open up the possibility of replacing gold with aluminum in PPPD production, significantly reducing their cost and, consequently, the cost of dust-proof smoke detectors.

However, aluminum films in air are covered with a thin oxide layer, which may lead to a small shift in plasmon resonance in the angular and spectral dependences of the photocurrent. The oxidation process is accelerated at increasing temperature. Therefore, it was advisable to

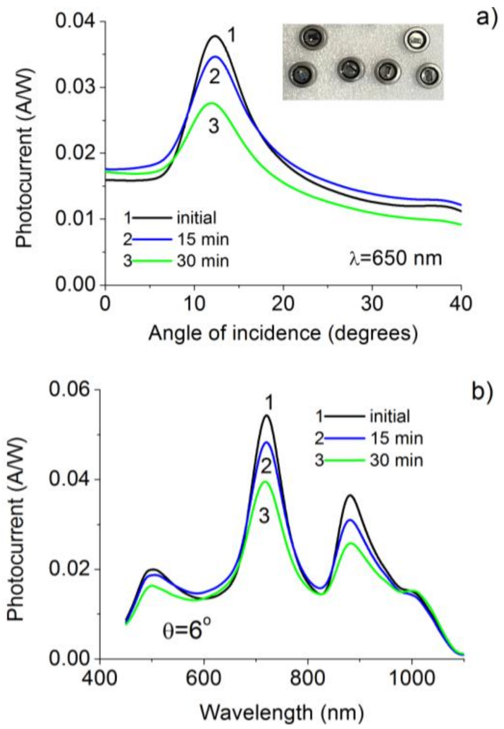


**Fig. 3.** Angular (a) and spectral (b) photocurrent dependences of the PPPD with Al grating on the surface before (*1*) and after 15 (*2*) and 30 (*3*) min of exposure to dust in the chamber. The photocurrent values are normalized to the power of the incident radiation.

conduct temperature tests of the optimized PPPDs based on Al gratings. Thermal cycling tests of the PPPD samples were carried out in a chamber where the air temperature was first raised to the maximum operating temperature multiplied by 1.5, *i.e*. to 60 °C. This temperature was maintained for 2 hours. Then the temperature was lowered to the minimum operating temperature multiplied by 1.5 (to –40 °C) and also maintained for 2 hours. Ten temperature test cycles were carried out. The rate of temperature change in the chamber was 1 °C/min.

It was found that after ten cycles of the thermal cycling tests, the shape of the SPP resonance of the studied samples in both the spectral and angular dependences of the photocurrent remained virtually unchanged. Only a slight shift of the maxima was observed: 3 nm for the photocurrent spectra and ~0.2° for the angular dependence of the photocurrent. If we assume that this shift is caused by oxidation of the aluminum film, we can estimate the thickness of the oxide formed as a result of the thermal cycling tests. We used an approximate formula proposed by Homola [13], which relates the change in the effective refractive index of SPP (and the shift of the resonant angle in Fig. 3b) to the optical thickness of the thin dielectric film deposited on the grating surface. An increase in the oxide layer thickness due to the thermal tests of the PPPD by 1.6 nm was obtained. Such small changes in the grating surface cause the above-mentioned minor shifts in the resonance position of the PPPD, which are more than an order of magnitude smaller than the response threshold of the corresponding smoke detector. Therefore, thermally stimulated oxidation of the aluminum grating during operation is insignificant and will not affect the detector operation.

Measurements of current-voltage characteristics of the PPPD samples before and after the thermal cycling tests have shown that the characteristics were completely reproduced after the temperature tests, with no substantial changes registered.

To assess the effect of humidity on smoke sensors based on PPPD, the spectral (at a light incidence angle of 6°) and angular (at a wavelength of 650 nm) dependences of the sample photocurrent were measured at ambient humidity levels of 30% and 100%. Only a slight change in these characteristics was observed after a ten-minute exposure of the PPPD to the maximum humidity. In particular, the SPP resonance in the photocurrent spectrum shifted slightly (by < 0.5 nm) toward the long-wavelength region of the spectrum. The angular position of the SPP resonance also shifted toward larger angles by < 0.2°. These changes are related to the higher refractive index of humid air compared to dry air and are 25…50 times smaller than the response threshold of such a detector. Hence, even the maximum humidity of the surrounding air will not affect the PPPD characteristics.

## 5. Conclusions

A design of a smoke detector based on PPPD, which is insensitive to shading the PPPD surface by dust particles and registers only the presence of smoke particles, has been developed. Using the results of numerical modeling and optimization of the resonant characteristics of PPPD, experimental samples of such photodetectors were manufactured based on a *p-n* junction in a silicon wafer, on the working surface of which a gold or aluminum grating was applied, fabricated using interference photolithography technology. As a result of testing the manufactured samples of the smoke detectors, it was established that dust, humidity of the surrounding air, and thermally stimulated oxidation of the aluminum grating during operation do not affect the detector operation.

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## References

1. Husted B.P. *Optical smoke units and smoke potential of different products*. DIFT report. 2004. **1**. https://doi.org/10.13140/RG.2.2.26154.88002.
2. Fleming J.M. *Photoelectric and ionization detectors* – A review of the literature – re-visited. National Fire Protection Research Foundation Symposium, Orlando, Florida, January 2005.

3. Kruell W., Schultze T., Tobera R, Willms I. Analysis of dust properties to solve the complex problem of non-fire sensitivity testing of optical smoke detectors. *Procedia Eng*. 2013. **62**. P. 859–867. https://doi.org/10.1016/j.proeng.2013.08.136.
4. Fonollosa J., Solórzano A., Marco S. Chemical sensor systems and associated algorithms for fire detection: A review. *Sensors*. 2018. **18**, No. 2. P. 553. https://doi.org/10.3390/s18020553.
5. Voytovich I.D., Korsunsky V.M. *Plasmon Resonance-based Sensors: Principles, Technologies, Applications*. K.: Stal, 2011.
6. *Patent 91922 Ukraine*, CI (2006.01) G08B 17/10. Multichannel smoke detector. Dorozhynskyi G.V., Maslov V.P., Kachur N.V., Filonchuk R.L. u2014 00277. Appl. 13.01.2014. Publ. 25.07.2014, Bull. 14.
7. Berthold K., Beinstingl W., Berger R., Gornik E. Surface plasmon enhanced quantum efficiency of metal-insulator-semiconductor junctions in the visible. *Appl. Phys. Lett.* 1986. **48**. P. 526–528. https://doi.org/10.1063/1.96495.
8. Korovin A.V., Dmitruk, N.L., Mamykin S.V. *et al.* Enhanced dielectric environment sensitivity of surface plasmon-polariton in the surface-barrier heterostructures based on corrugated thin metal films with quasi-anticorrelated interfaces. *Nanoscale Res. Lett*. 2017. **12**. P. 213. https://doi.org/10.1186/s11671-017-1974-3.
9. Gnilitskyi I., Mamykin S., Dusheyko M. *et al.* Diffraction gratings prepared by HR-LIPSS for new surface plasmon-polariton photodetectors & sensors. *Front. Opt*. 2016. P. JW4A.88. https://doi.org/10.1364/FIO.2016.JW4A.88.
10. Lyaschuk Yu., Indutnyi I., Myn'ko V. *et al.* Aluminum-based plasmonic photodetector for sensing applications. *Appl. Sci*. 2024. **14**. P. 4546. https://doi.org/10.3390/app14114546.
11. Dan'ko V., Dmitruk M., Indutnyi I. *et al.* Au gratings fabricated by interference lithography for experimental study of localized and propagating surface plasmons. *Nanoscale Res. Lett.* 2017. **12**. P. 190. https://doi.org/10.1186/s11671-017-1965-4.
12. UL217 – *Single and Multiple Station Smoke Alarms*. Underwriters Lab. Inc., Northbrook, IL, 60062.
13. Homola J. Surface plasmon resonance sensors for detection of chemical and biological species. *Chem. Rev*. 2008. **108**. P. 462–493. https://doi.org/10.1021/cr068107d.


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**Indutnyi I.Z.:** conceptualization, methodology, measurements, writing – original draft, writing – review & editing.
**Redko R.A.:** investigation, validation, writing – review & editing, methodology.
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**Нечутливий до пилу детектор диму на основі плазмон-поляритонного фотодетектора**

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**Анотація.** У даному дослідженні запропоновано детектор диму на основі плазмон-поляритонного фотодетектора (ППФД), з допомогою якого вирішується проблема хибного спрацювання датчиків диму оптичного типу в умовах високої запиленості приміщення. У запропонованому датчикові використовується ППФД на основі *p-n* переходу в кремнієвій пластині, на робочу поверхню якої за технологією інтерференційної фотолітографії нанесена металева ґратка для збудження плазмон-поляритонного резонансу. Розроблено конструкцію детектора диму на основі ППФД, яка дозволяє виготовити достатньо компактний та дешевий прилад. У результаті оптимізації параметрів ППФД на основі Au та Al ґраток були досягнуті такі характеристики експериментальних зразків: максимальна поляризаційна чутливість $I_p/I_s$ від 3 до 8, спектральна та кутова півширина резонансу фотоструму – від 50 до 200 нм та від 5° до 10° відповідно, максимальне значення фоточутливості $I_{ph}$ = 0.04...0.1 A/W.

**Ключові слова:** поверхневий плазмонний резонанс, плазмон-поляритонні фотодетектори, детектор диму.