Tunable Surface Plasmon Wave Plates

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Abstract: The highest resonant transmission through an array of holes perforated in metallic screens occurs when the dielectric constant of the substrate, the superstrate and the hole are the same. Changes in the refractive index of the homogenous environment also produce the largest shift in resonances per refractive index unit. In this report, we first propose and apply a technique in realization of free standing bi-periodic array of holes perforated in a silver film. We then show both numerically and experimentally that shifts in (1,0) and (0,1) modes in response to changes in the refractive index of the surrounding dielectric provide a mechanism for realization of a miniaturized tunable quarter waveplate that operates in extraordinary optical transmission mode with a high throughput and a near unity state of circularly polarized light.

Some plasmonic devices such as quarter wave-plates [1-3] and frequency dependent optical beam steers [4] rely on two carefully spaced orthogonal modes to achieve their primary objectives. Arrays of cylindrical holes are relatively simpler to fabricate in comparison to those that rely on shape resonances. Previously, the wave-plate functionality of a bi-periodic array of cylindrical holes was demonstrated at a design wavelength [5]. It is highly desirable, however, to make such devices tunable without fabricating numerous arrays with different dimensions that operate at other wavelengths. Refractive index based plasmonic sensors rely on the shift in surface plasmon resonance (SPR) in response to a change in the surrounding dielectric environment making them ideal for the next generation of miniaturized sensing devices [6-8] and spectroscopy[9-11]. SPRs are also the fundamental reason behind other effects such as the color filter functionality [12]. Considering optical filters and waveplates, devices that operate in Extraordinary Optical Transmission (EOT) mode are analogues to their classical counterparts where the properties of an incandescent light passing through an optical element are altered on transmission, hence more suitable for miniaturization. In accordance with Krishnan et al.[13], our numerical analysis confirmed that the highest resonant transmission through an array of holes perforated in metallic screens occurs in a symmetric setting where the dielectric constant of the substrate, the superstrate and the hole are the same. Changes in the refractive index of the environment also produced the largest shift in resonance in comparison to other scenarios where the substrate differed from the superstrate. Here, we investigate the possibility of the shift in resonances observed in refractive index based sensors being applied to a bi-periodic array of holes surrounded by a homogenous dielectric environment. The proposed device operates in EOT mode, hence achieving a miniaturized tunable quarter waveplate by means of controlling the polarization of the incident light as well as the dielectric medium surrounding the array homogeneously.

A unit cell of the previously reported bi-periodic array [5] was modelled in a homogenous environment using Finite Element Method (FEM). Film surface was set parallel to the *x*-*y* plane with P_x and P_y being aligned with the *x* and the y axes respectively. The device was normally illuminated with a linearly polarized light propagating in the +*z* direction, (with the polarization angle, α, measured with respect to the x-axis). Periodic boundary conditions were implemented to extend the lateral dimensions of the array to infinity and scattering boundary conditions (SBC) were set to minimize the back scattered light from the top and the bottom boundaries of the model. Redshifts in (1,0)SPP and (0,1)SPP resonances vs. the change in the refractive index were calculated to be $\Delta\lambda_{0x}/\Delta n$ = 458 nm per refractive index unit (RIU) and $\Delta\lambda_{0y}/\Delta n$ = 496 nm per RIU for P_x and P_y respectively, see Fig. 1. A high transmission of $0.81 \leq T_n \leq 0.89$ was maintained at $\lambda_{(1,0)}$ and $\lambda_{(0,1)}$ with variations in the maximum transmitted power vs. the change in the refractive index being $\Delta T/\Delta n = (T_1 - T_{1.52})/0.52 \approx +0.15$. The shift from $\lambda_{(1,0)}$ to $\lambda_{(0,1)}$ vs. α was found to be $\sim n_{0.35}$ RIU nm/degree. Degrees of circularly polarized light (CPL) were calculated on transmission using:

$$S_3 = \frac{2\mathrm{Im}\left[E_{\mathrm{tx}}E_{\mathrm{ty}}^{*}\right]}{\left|E_{\mathrm{tx}}\right|^2 + \left|E_{\mathrm{ty}}\right|^2} \qquad (1)$$

where E_{tx} and E_{ty} are the x and the y components of the transmitted electric field. Stokes parameters were found to be $S_3 = 0.91$ at $512 \leq \lambda_{\mathrm{CPL}} \leq 518$ nm and $S_3 = 0.95$ at $756 \leq \lambda_{\mathrm{CPL}} \leq 766$ nm for $n = 1$ and $n = 1.52$ respectively, with optimum incident polarization angle being in the range of $50° \leq \alpha \leq 60°$ in both cases. Transmission near unity are attributed to the interaction between the Fabry-Pérot (FP) oscillations inside the holes and the propagating SPPs on the surface. This implies that the transmission at $\lambda_{(1,0)}$ (or $\lambda_{(0,1)}$) is dictated by the offset between the surface mode and the FP resonance. The fundamental SPP mode at $\lambda_{(0,1)} \approx 790$ nm for $n = 1.52$ with a transmission of 0.89, for example, is attributed to the coupling of the FP mode inside the cavities to the SPP waves on the film. Such a high transmission depends on the film thickness, array periodicity and the diameter of the holes and the surrounding dielectric, hence the Fabry-Pérot Evanescent Wave (FPEV)[14]. Observation of such a high transmission is remarkable given that the only structural related variable here is the surrounding dielectric.

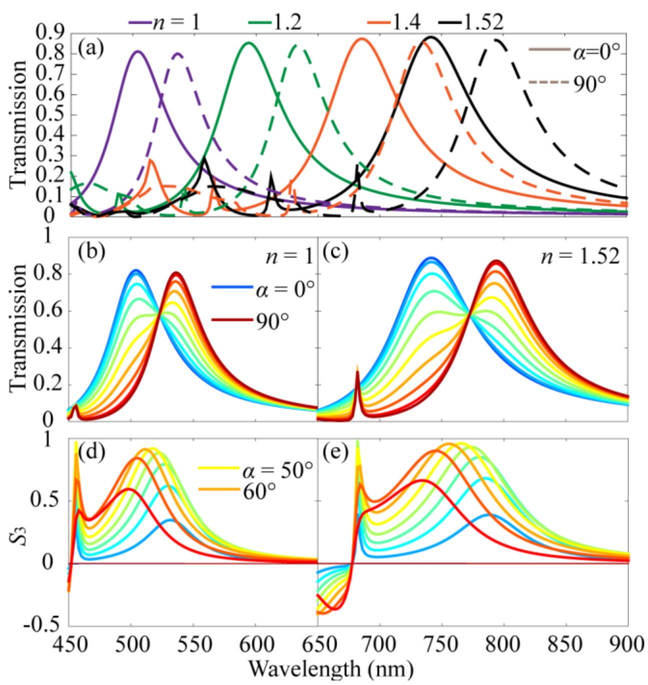

Fig. 1: Numerical results for a bi-periodic array of holes, having diameters $d = 180$ nm with periodicities $P_x = 366$ nm and $P_y = 417$ nm, perforating a 80 nm silver film, when excited with a normally incident field. (a) Normalized transmission vs. the wavelength for $n = \{1, 1.2, 1.4, 1.52\}$. (b) Normalized transmission vs. the wavelength at various incident polarizations $0° \leq \alpha \leq 90°$ for (b) $n = 1$ and (c) $n = 1.52$. Stokes parameter for circularly polarized light, S3, vs. the wavelength at various incident polarizations $0° \leq \alpha \leq 90°$ for (d) n = 1 and (e) $n = 1.52$.

Realization of such array posed a challenge. There are no known techniques (at least to the authors) for fabricating, handling and characterizing an array in a free-standing 80 nm thin silver film. With silver being impervious to hydrofluoric (HF) acid etchings [15], however, it was envisaged that immersing the prefabricated array (supported on a glass substrate) in a HF solution, would result in the HF penetrating through the holes, etching the glass substrate just under the array while leaving the rest of the silver film attached to the glass. The array was initially etched in a 30% HF solution for 30 sec followed by a rinse and a spectral measurement. This process was then repeated until the (0,1) and (1,0) modes associated with the glass/silver interface disappeared from the spectrum and the (0,1) and (1,0) modes at the air/silver interface gained their full strength. This resulted in an array surrounded by a homogenous environment with a refractive index $n = 1$, Fig. 2 shows the schematics. Once the measurements were concluded for $n = 1$, a single drop of optical immersion oil with a refractive index matching that of the glass was placed over the device and left overnight to allow the oil to penetrate the holes, filling the space beneath the array as well as the cavities. A microscope cover slip was placed on top of the device to flatten the convexed excess oil. This represents an array in a homogenous environment with a refractive index n = 1.52. Measurements were repeated and upon completion, excess oil was partially removed and a cross-sectional image was produced using a dual-beam, focused ion beam and scanning electron microscope (FIB-SEM), see Fig. 2(c) and (d).

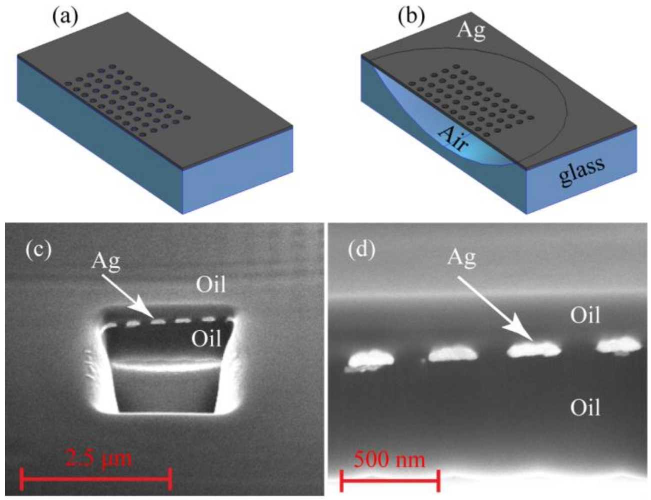

Fig. 2: Cross-sectional schematics of the array (a) before and (b) after etching with HF. (c) cross-sectional SEM image of the freestanding array in a homogenous dielectric environment (immersion oil). (d) Close-up of (c).

In both cases normalized transmissions were measured using the previously reported technique [5]. The degree of transmitted circularly polarized light, S3, was obtained using the technique suggested by Kihara [16] that takes into account the phase difference error using:

$$S_3 = \frac{\left[I(0°,45°) - I(0°,135°)\right] + S_2 \sin(\Delta)}{\left[I(0°,0°) + I(90°,90°)\right]\cos(\Delta)} \qquad (2)$$

where $S_2 = [I(45°,45°) - I(135°,135°)]$ and $\Delta = \sin^{-1}[\, I(0°,135°)_{ini} - I(0°,45°)_{ini}\,]$. Note that $I(\beta_2, \alpha_2)$ is the light intensity emerging from the analyzer towards the spectrometer with α_2 and β_2 being angles that transmission axis of the analyzer and the fast axis of the quarter waveplate (not to be mistaken with our device) makes with the *x*-axis respectively. $I(0°,135°)_{ini}$ and $I(0°,45°)_{ini}$ intensities are to be measured with $\alpha = 45°$ in the absence of our array. Being an argument to an arcsine function, $I(\beta_2, \alpha_2)_{ini}$ must be normalized to the incident intensity. Fig. 3 depicted the experimental results.

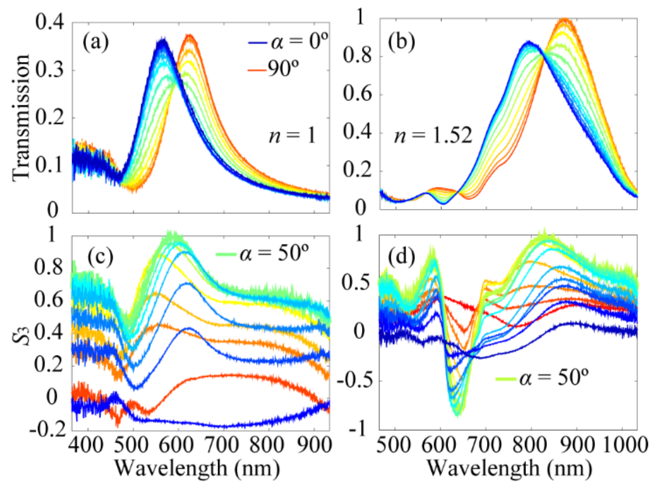

Fig. 3: Experimentally obtained results for incident polarization $0° \leq \alpha \leq 90°$. Normalized transmission vs. the wavelength for (a) $n = 1$ and (b) $n = 1.5$. S_3 vs. the wavelength for (c) $n = 1$ and (d) $n = 1.52$.

Sensitivities measured $\Delta\lambda_{0x}/\Delta n = 436$ nm per RIU and $\Delta\lambda_{0y}/\Delta n = 476$ nm per RIU for P_x and P_y respectively. An average of ~70 nm constant excess redshift in $(1,0)_{SPP}$ and $(0,1)_{SPP}$ modes observed experimentally (in comparison to those obtained numerically) may be attributed to various factors such as the effect of temperature rising during the measurements[17-20], surface roughness in the film[21-23], use of refractive index data for bulk silver in modelling nanoscale features[24] and fabrication defects. In the case of $n = 1$, experimentally obtained transmission of 0.38 (vs. the simulated peak transmission of ~0.81) is due to the presence of the glass substrate beneath the air gap that results in internal reflections, hence reducing the coupling between the light and the SPPs. The 100% transmission at $\lambda_{(0,1)} = 874$ nm observed for $n = 1.52$ is attributed to the perfect alignment between the FP resonance and the (0,1) mode. To the best of our knowledge, this is the first experimental demonstration of Fan's predictions [25-27], that no matter how small the cylindrical hole, at some wavelength near-complete optical transmission occurs. This is significant given that it occurs for $d/\lambda_{(0,1)} = 0.2$. Experimentally measured S3 parameters revealed a high degree of CPL being transmitted with $\alpha \approx 50°$ in both cases, with $S_3 = 0.99$ at $\lambda_{CPL} = 587$ nm and $S_3 = 0.98$ at $\lambda_{CPL} = 828$ nm for $n = 1$ and for $n = 1.52$ respectively. These are near-perfect states of CPL being transmitted, and have potential applications in novel displays, sensing devices, optical communication systems and microscopy. With a simple planar geometry and well defined Fano resonance line shapes, such a device is an attractive platform for implementing miniaturized refractive index sensors, tunable color filters and tunable quarter waveplates covering the visible and the near-IR regions. This simple design is also very suited to nano imprint lithography [28] making it cost effective for mass production.

Declaration: The author (S. Amir H. Djalalian-Assl) declares no conflict of interest. No funding or remuneration of any kind was availed to the author during the work presented in this report. The author is the sole individual responsible for the inception of the idea, the design of the study, relevant measurements, collection, analyses, interpretation of data, the writing of the manuscript and the decision to disseminate the results.

Submission History:

ACS Photonics

support@services.acs.org <support@services.acs.org> Mon, Apr 4, 2016 at 9:08 PM
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04-Apr-2016

RE: Manuscript Successfully Submitted
Journal: ACS Photonics
Manuscript ID: ph-2016-002316
Title: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities"
Authors: Djalalian-Assl, Amir; Cadusch, Jasper; Aramesh, Morteza

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eic@photonics.acs.org <eic@photonics.acs.org> Sun, Apr 17, 2016 at 11:22 AM
To: amir.djalalian@gmail.com
Cc: amir.djalalian@gmail.com, jcadusch@student.unimelb.edu.au, J.cadusch@pgrad.unimelb.edu.au, s1faras@gmail.com

16-Apr-2016

RE: Manuscript Editor Assignment
Journal:ACS Photonics
Manuscript ID: ph-2016-002316
Title: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities"
Authors: Djalalian-Assl, Amir; Cadusch, Jasper; Aramesh, Morteza

Dear Mr. Djalalian-Assl:

Your manuscript entitled "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities" has been assigned to the following editor:

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16-Apr-2016

ACS Photonics
Manuscript ID: ph-2016-002316
Title: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities"
Author(s): Djalalian-Assl, Amir; Cadusch, Jasper; Aramesh, Morteza

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From: <quidant-office@photonics.acs.org>
Date: Tue, Apr 19, 2016 at 2:05 AM
Subject: Djalalian-Assl, Amir ph-2016-002316 - Manuscript Decision 18-Apr-2016
To: amir.djalalian@gmail.com

18-Apr-2016

Journal: ACS Photonics
Manuscript ID: ph-2016-002316
Title: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities"
Author(s): Djalalian-Assl, Amir; Cadusch, Jasper; Aramesh, Morteza

Dear Mr. Djalalian-Assl:

Thank you for submitting your manuscript to ACS Photonics. The editors have reviewed your manuscript reporting on plasmonic refractive index sensing, and have determined that it is unlikely to be competitive for publication in ACS Photonics. In particular, ACS Photonics seeks reports of conceptually new photonic phenomena. While the present manuscript reports a well-conducted set of experiments, the results do not constitute a sufficiently significant advance over the state-of-the-art to warrant publication in ACS Photonics. We receive far more papers than can be published and we must make decisions based on likely scientific impact and interest to our readership. Such decisions are made prior to the review stage to enable you and your co-authors to submit it rapidly for publication elsewhere. While I regret that our decision cannot be more positive in this instance, we welcome your future submissions to ACS Photonics.

Sincerely,

Prof. Romain Quidant
Associate Editor
ICFO- The Institute of Photonic Science
Journal Email: quidant-office@photonics.acs.org
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APL: Receipt of Manuscript MS #L16-02787

apl-edoffice@aip.org <apl-edoffice@aip.org> Tue, Apr 19, 2016 at 10:17 PM
Reply-To: apl-edoffice@aip.org
To: amir.djalalian@gmail.com

Dear Mr. Djalalian-Assl,

On 19-Apr-2016, we received the manuscript entitled: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities".
Your manuscript is assigned the Manuscript #L16-02787.

The order of the authors on your submitted manuscript is as follows: Amir Djalalian-Assl, Jasper Cadusch, and Morteza Aramesh.
Please note that if this order is changed or if there are any deletions or additions of authors, each author must provide approval for this change.

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APL: MS #L16-02787 Receipt of New Manuscript

apl-edoffice@aip.org <apl-edoffice@aip.org> Wed, Apr 20, 2016 at 2:15 AM
Reply-To: apl-edoffice@aip.org
To: amir.djalalian@gmail.com

Dear Mr. Djalalian-Assl,

On 19-Apr-2016, your manuscript passed the submission check and has now entered the editorial process.

Title: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities"
Author: Amir Djalalian-Assl, Jasper Cadusch, and Morteza Aramesh.

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Applied Physics Letters

APL: MS #L16-02787 Decision Letter

apl-edoffice@aip.org <apl-edoffice@aip.org> Tue, May 10, 2016 at 9:13 AM
Reply-To: apl-edoffice@aip.org
To: amir.djalalian@gmail.com

Dear Mr. Djalalian-Assl:

Your manuscript, referenced below, has been reviewed for publication in Applied Physics Letters.

"Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities"

L16-02787

In light of the recommendations of the reviewers, we have decided not to accept your paper for publication in Applied Physics Letters. Applied Physics Letters seeks to publish work that makes a significant advance in the field and is of broad interest to the community. Based on the reviewers' comments, we find the manuscript is scientifically sound but did not fulfill these criteria.

In particular, both reviewers have concerns on the relatively limited advance the present paper made as compared to earlier works.

However, we find that with minor revisions, your manuscript would merit immediate publication in AIP Advances. AIP Advances is an Open Access journal focused on rapid publication of original, scientifically sound articles in all areas of the physical sciences.

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For your convenience, please find the reports of the reviewers attached or included below.

Thank you for the opportunity to examine this work. If you have any questions, feel free to contact us at apl-edoffice@aip.org.

Sincerely yours,

Shanhui Fan
Associate Editor,
Applied Physics Letters

AIP Publishing
Suite 300
1305 Walt Whitman Road
Melville, NY 11747-4300 USA

Phone: 516-576-2344
E-mail: apl-edoffice@aip.org

Reviewer Comments:

Reviewer #1 Evaluations:
Does this paper meet APL's standards: No
Is the paper scientifically sound with the assertions made and conclusions drawn well supported: Yes
Is the discussion of related work and associated references adequate?: No
Is the English satisfactory?: Yes
Is the title short, interesting, and descriptive of the contents?: Yes
Is the paper well organized and understandable?: Yes

Reviewer #1 (Comments to the Author):

In the manuscript: "Polarization Dependent Plasmonic Refractive Index Sensor Based on Surface Modes with Tunable Color Filter and Quarter Waveplate Functionalities," the authors explore analytically and numerically the transmission properties of aperture arrays (also in a symmetric environment) under the influence of refractive index change. The work seems generally correct, however, I do not believe that it makes a significant contribution to the field in light of past works on rectangular arrays. For example, in DOI: 10.1364/OE.19.015041, the polarization dependent tuning (sensing) characteristics are explored (including experiments). There are other similar works in the literature. Therefore, I feel that this work is not suitable for APL.

Reviewer #2 Evaluations:
Does this paper meet APL's standards: No
Is the paper scientifically sound with the assertions made and conclusions drawn well supported: No
Is the discussion of related work and associated references adequate?: Yes
Is the English satisfactory?: Yes
Is the title short, interesting, and descriptive of the contents?: No
Is the paper well organized and understandable?: Yes

Reviewer #2 (Comments to the Author):

The authors investigate analytically and experimentally the transmission through a bi-periodic array of holes in a silver film surrounded by a homogenous dielectric. They show that the shift in (1,0) and (0,1) modes in response to the change in the refractive index of the dielectric provides a mechanism for realization of a polarization dependent refractive index sensor, a tunable quarter waveplate, and a tunable color filter.

The model described in the paper pertains to two isolated nanoholes. It is not clear how it applies to a hole array. Moreover, the model is incomplete. It incorporates the physics for the SPP launched from the nano-size holes (please provide reference for this model). It does not, however, include the physics of the mode supported by the holes, i.e. the mode that is responsible for the FP resonance. This resonance is clearly important to achieve the large transmission and Fig. 3 shows how the film thickness is optimized for this resonance.

Not sufficient evidence is provided for applications beyond refractive index sensing. Moreover, the wave plate application was previously reported by the authors using the same structure geometry.

As a final remark, the transition into the experimental part on page 7 is abrupt and it seems like some text was left out.

APL: MS #L16-02787 Appeal Request Declined

apl-edoffice@aip.org <apl-edoffice@aip.org> Sat, May 14, 2016 at 2:14 AM
Reply-To: apl-edoffice@aip.org
To: amir.djalalian@gmail.com

Dear Amir,

Thanks for the note. In response to your request, we have re-examined the comments of the reviewers and your original manuscript. We see no reason to overturn the recommendation of our reviewers, and therefore have decided not to further consider this manuscript.

We are sorry to hear about the publication charge for AIP advances. Unfortunately there is very little we can do. But we do wish you the best of luck in seeking an appropriate venue in publishing your work. And thanks again for your interest in APL.

Sincerely,

Shanhui

Shanhui Fan
Associate Editor
Applied Physics Letters

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Melville, NY 11747-4300 USA

Phone: 516-576-2344
E-mail: apl-edoffice@aip.org

APL: MS #L16-02787 Appeal Request Declined

amir djalalian-assl <amir.djalalian@gmail.com>
To: Shanhui@stanford.edu

Sat, May 14, 2016 at 7:29 PM

Dear Prof. Fan,

Thank you for the reply on APL: MS #L16-02787. I do understand. I'll prepare the manuscript for some other journal.

I have, however, a question regarding you previous work on cylindrical holes. I came across you previous publications [1-3] predicting that at some wavelength a 100% transmission occurs. I believe that the perfect transmission at $\lambda_{(0,1)}$ = 874 nm I observed for n = 1.52 is the direct experimental proof of what you predicted. I think this is significant even more so that it happens for $d/\lambda_{(0,1)}$ = 0.2 (I must certainly cite your previous work).

If you don't mind me asking, has there been any experimental demonstration of your work in the past? I search but I couldn't find any.

Regards,

Amir Djalalian-Assl

1. Catrysse, P.B. and S.H. Fan, *Propagating plasmonic mode in nanoscale apertures and its implications for extraordinary transmission.* Journal of Nanophotonics, 2008. **2**.
2. Catrysse, P.B., H. Shin, and S.H. Fan, *Propagating modes in subwavelength cylindrical holes.* Journal of Vacuum Science & Technology B, 2005. **23**(6): p. 2675-2678.
3. Shin, H., P.B. Catrysse, and S. Fan, *Effect of the plasmonic dispersion relation on the transmission properties of subwavelength cylindrical holes.* Physical Review B, 2005. **72**(8).

APL: MS #L16-02787 Appeal Request Declined

Shanhui Fan <shanhui@stanford.edu> Sun, May 15, 2016 at 7:07 AM
To: amir djalalian-assl <amir.djalalian@gmail.com>

Dear Amir,

Good luck with your paper. I have not come across any direct experimental observation of what we have predicted. So what you are saying could be quite interesting. In Ref. [1] we have an analytic model for the frequency range of the modes, is the peak that you observe within that range?

Best regards,

-Shanhui

Shanhui Fan
Professor of Electrical Engineering
Director, Edward L. Ginzton Laboratory
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OSA:

Acknowledgment of Optics Letters submission (266570)

olmss@osa.org <olmss@osa.org> Fri, May 20, 2016 at 3:11 AM
To: amir.djalalian@gmail.com
Cc: jcadusch@student.unimelb.edu.au, s1faras@gmail.com

Manuscript ID: 266570
Title: Tunable Surface Plasmon Wave Plates
Author: Amir Djalalian-Assl; The university of Melbourne

Dear Amir Djalalian-Assl;

Your recent submission to Optics Letters has been received successfully and will now enter the peer-review process. The date of this message is the official receipt date for your manuscript. OSA will inform you when further action is required.

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Thank you for submitting your work to Optics Letters.

Sincerely,
Xi-Cheng Zhang
Editor-in-Chief

Decision for Optics Letters manuscript 266570

olmss@osa.org <olmss@osa.org> Sat, May 28, 2016 at 3:49 AM
To: amir.djalalian@gmail.com, jcadusch@student.unimelb.edu.au, s1faras@gmail.com

Manuscript ID: 266570 Type: letter
Title: Tunable Surface Plasmon Wave Plates
Author: Amir Djalalian-Assl; The university of Melbourne

Dear Dr. Djalalian-Assl:

Your manuscript can be considered for publication in Optics Letters provided that you make mandatory revisions to your manuscript that address the reviewer concerns. The reviews are appended below.

It is the policy of Optics Letters to allow only one revision. Thus it is important to respond to all of the reviewer points and to make it evident that you have done so. For this reason, please note any changes that have been made to the manuscript, and their location, in your response. You will copy and paste your response into a designated comment text box provided online, or if you prefer you may upload your response file in the space provided. Failure to provide a list of revisions and indicate the changes in the revised manuscript will result in delay in the publication or rejection of the manuscript. Of course, you may not agree with the reviewers on every point; in this case, your responses and reasoning should be clearly presented.

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Thank you for your contribution to Optics Letters. If you have any questions, please contact the Manuscript Office at olmss@osa.org.

Sincerely,
Xiaoyong Hu
Topical Editor, Optics Letters

--------Reviewer Comments--------

Reviewer 1:
In this letter, Djalalian-Assl et al report on a plasmonic structure and its applicative potential for optical sensing. The plasmonic structure is a free-standing silver film etched with a biperiodic array of holes. The authors investigate the spectral dependence of the transmission modes on the local refractive index. Methods include polarization-resolved optical transmission spectroscopy and finite-element-method calculations. Thus the authors evaluate the sensitivity of this platform as a sensor for local refractive index variations.

To my opinion, the scientific quality and technical content of the letter is appropriate for publication in Optics Letters. I recommend acceptance of the letter for publication in Optics Letters after minor corrections suggested below.

-- p. 1, left, in abstract and below, "EOT" should be written unabbreviated and defined.
-- p. 1, right, above Eq. 1, "alpha" should be defined.
-- p. 2, right, "This resulted in a free-standing array that was still attached to the substrate", this should be supported by electronic microscopy images, which should be shown.
-- p. 2, right, "S3 parameters" should be explicitely explained and defined.
-- p. 3, left, the applicative potential of the investigated plasmonic structures for waveplates is not clear. Please explain to help the reader understand the point.
-- p. 3, references, the page numbers are missing in several references.

266570 Revised manuscript received

olmss@osa.org <olmss@osa.org> Wed, Jun 1, 2016 at 1:22 AM
To: amir.djalalian@gmail.com

Manuscript ID: 266570 TYPE: letter
Title: Tunable Surface Plasmon Wave Plates
Author: Amir Djalalian-Assl; The university of Melbourne

Dear Dr. Djalalian-Assl,

Thank you for submitting a revised manuscript. The topical editor will review the changes and notify you of the final decision.

Optics Letters Automated Response
olmss@osa.org

Decision for revised Optics Letters manuscript 266570

olmss@osa.org <olmss@osa.org> Fri, Jun 10, 2016 at 12:01 AM
To: amir.djalalian@gmail.com, jcadusch@student.unimelb.edu.au, s1faras@gmail.com, E.Balaur@latrobe.edu.au

Manuscript ID: 266570 Type: letter
Title: Tunable Surface Plasmon Wave Plates
Author: Amir Djalalian-ASSL; University of Melbourne

Djalalian-ASSL:

I am pleased to confirm that your revised manuscript has been accepted for publication in Optics Letters. Please direct future correspondence to the Managing Editor at dfranz@osa.org.

You will have an opportunity to review PDF proofs of the typeset pages of your paper prior to publication. Please watch for emailed instructions from the printer several weeks from now. To ensure delivery, please make sure that you notify OSA of any changes to your email address.

Upon receipt of the proofs, please respond promptly with your corrections to help ensure that your paper can be included in the next available issue of the journal.

In the meantime, you may track the status of your paper at the Optics Letters author website, http://prism.osapublishing.org/Author

Thank you for your contribution.

Sincerely,
Xiaoyong Hu
Topical Editor, Optics Letters

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