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SEARCH REPORT

Application Number

LH 39
LT 2024503

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	MANSOURI FARIBA ET AL: "Cu-Au core-shell nanostructures induced by ArF excimer laser irradiation", JOURNAL OF LASER APPLICATIONS, AMERICAN INSTITUTE OF PHYSICS, 2 HUNTINGTON QUADRANGLE, MELVILLE, NY 11747, vol. 35, no. 1, 3 January 2023 (2023-01-03), XP012271242, ISSN: 1042-346X, DOI: 10.2351/7.0000835 [retrieved on 2023-01-03]	1-4,6-8	INV. G01N21/552
Y	* pages 012010-2 *	9,12	
A	* pages 012010-6 * * figures 4a-4d *	5,10,11, 13	

X	LT 6 558 B (VALSTYBINIS MOKSLINIU TYRIMU INSTITUTAS FIZINIU IR TECH MOKSLU CENTRAS) 10 October 2018 (2018-10-10)	10,13	
Y	* the whole document *	12	
A		1-9,11	

Y	MATTEO TODESCHINI ET AL: "Influence of Ti and Cr Adhesion Layers on Ultrathin Au Films", APPLIED MATERIALS & INTERFACES, vol. 9, no. 42, 11 October 2017 (2017-10-11), pages 37374-37385, XP055573861, US ISSN: 1944-8244, DOI: 10.1021/acsami.7b10136 * page 37383, column 1, paragraph 2 *	9	TECHNICAL FIELDS SEARCHED (IPC) G01N B22F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 July 2024	Huenges, Alexandra

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 11.08 (P04C80)

ANNEX TO THE SEARCH REPORT ON LITHUANIAN PATENT APPLICATION NO.

LH 39
LT 2024503

This annex lists the patent family members relating to the patent documents cited in the above-mentioned search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-07-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
LT 6558 B	10-10-2018	NONE	

EPO FORM P04A4

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
LH39	18.01.2024		LT2024503

International Patent Classification (IPC)
INV. G01N21/552

Applicant
Fiziniu ir technologijos mokslu centras

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of the opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Examiner
Huenges, Alexandra

Application number

WRITTEN OPINION

LT2024503

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the application as filed.

   b. ☐ furnished subsequent to the filing date for the purposes of search,

      ☐ accompanied by a statement to the effect that the sequence listing does not go beyond the disclosure in the application as filed.

3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the application, this opinion has been established to the extent that a meaningful opinion could be formed without a WIPO Standard ST.26 compliant sequence listing.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	4-7, 9-13
	No:	Claims	1-3, 8
Inventive step (IS)	Yes:	Claims	5, 11
	No:	Claims	1-4, 6-10, 12, 13
Industrial applicability (IA)	Yes:	Claims	1-13
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Mentioned prior art

Reference is made to the following documents:

D1 MANSOURI FARIBA ET AL: "Cu-Au core-shell nanostructures induced by ArF excimer laser irradiation",
JOURNAL OF LASER APPLICATIONS, AMERICAN INSTITUTE OF PHYSICS, 2 HUNTINGTON QUADRANGLE, MELVILLE, NY 11747,
vol. 35, no. 1, 3 January 2023 (2023-01-03), XP012271242,
ISSN: 1042-346X, DOI: 10.2351/7.0000835
[retrieved on 2023-01-03]

D2 LT 6 558 B (VALSTYBINIS MOKSLINIU TYRIMU INSTITUTAS FIZINIU IR TECH MOKSLU CENTRAS) 10 October 2018 (2018-10-10)

D3 Matteo Todeschini ET AL: "Influence of Ti and Cr Adhesion Layers on Ultrathin Au Films",
Applied Materials & Interfaces,
vol. 9, no. 42, 11 October 2017 (2017-10-11), pages 37374-37385, XP055573861,
US
ISSN: 1944-8244, DOI: 10.1021/acsami.7b10136

D4 US 2021/190772 A1 (MENDES SERGIO BRITO [US] ET AL) 24 June 2021 (2021-06-24)

2 Lack of novelty of claim 1

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

D1 discloses the features of claim 1, namely:

a plasmonic sensor comprising a substrate of transparent material

(see D1, page 012010-2, col. 2, third paragraph: "... formation of Cu-Au composite plasmonic nanostructures on the surface of glass")

and an electrically conductive coating covering the substrate

(see D1, page 012010-2, col. 2, fourth paragraph: " Bimetallic layers were deposited onto 2mm thick, 20 mm diameter disc BK7 glass substrates...". At the area of laser irradiation, the bimetallic layers form nanostructures, but at areas outside the laser irradiation, the bimetallic layers are preserved, see figure 4a showing the laser spot and an area surrounding the laser spot which is not irradiated. In this area, the sample comprises a conductive/bimetallic coating covering the glass substrate)

in which plasmonic derivatives are arranged

(see the abstract of D1 disclosing the formation of Cu-Au nanospherical structures formed on glass surfaces by laser irradiation and see D1, page 012010-6, col. 2, second paragraph disclosing Cu-Au core-shell nanospheres),

wherein said coating is of a bimetal with layers of metals having plasmonic properties (see D1, page 012010-2, col. 2, fourth paragraph: " Bimetallic layers were deposited... First, Cu layers with a thickness of 50 nm were deposited on BK7 glass substrates. Then, 50 nm gold layers were deposited on the Cu film in the same way." Gold and copper are plasmonic materials)

and plasmonic derivatives arranged in bimetal coating is bilayer plasmonic derivatives obtained by laser treatment of the bimetallic coating layers

(see D1, page D1, page 012010-6, col. 2, second paragraph: "As shown in 4b – 4d, bimetallic nanospheres are formed in the whole irradiated area....This absorption peak is related to the bimetallic Cu-Au core-shell nanospheres." Core-shell nanospheres represent bilayer plasmonic derivatives of the bimetallic coating layers, because they contain two layers, a copper core and a gold shell.).

The disclosure of D1 thus anticipates the subject-matter of claim 1. Claim 1 is not new.

3 Lack of inventive step of method claim 10

D2 is regarded as being the prior art closest to the subject-matter of claim 10, and discloses

a method of forming a plasmonic sensor

(see figure 2 of D2),

wherein said plasmonic sensor has a substrate of transparent material and an electrically conductive coating covering the substrate in which plasmonic derivatives are formed

(see D2, par. 30: transparent substrate 12 and bimetallic layers 10, 11),

wherein said coating is of a bimetal with layers of metals having plasmonic properties

(see D2, par. 16 and 17; examples of bimetallic layers have plasmonic properties),

and each plasmonic derivative is formed individually by exposing the layers of the bimetallic coating in the area of the plasmonic derivative to be formed by a laser radiation to form a bilayer plasmonic derivative

(see D2, par. 31 "... different layers of metals 10 and 11 having magnetic and optical properties formed on a clear substrate 12 is exposed to laser radiation 2" and see par. 23: "In the proposed way, nanoparticles can be generated and precipitated selectively in the desired place of the substrate, and not just in the entire substrate." Paragraph 23 discloses selective generation of nanoparticles. This is interpreted as including individually forming plasmonic derivatives by laser radiation, hence the claimed feature. In case paragraph 23 cannot be interpreted as comprising the claimed feature, i.e. the formation of an individual derivative, this feature would not involve an inventive step. D2 discloses selective precipitation and the control of the diameter of the laser beam, see par. 30. When starting from D2 and facing the problem of generating the structure in a controlled manner, the skilled person would reduce the laser diameter in order to generate the nanoparticles individually, thereby arriving at the invention without inventive skill.)

wherein, after each formation of the bilayer plasmonic derivative, the substrate and the focusing point of the laser radiation are moved relative to each other and another bilayer plasmonic derivative is formed in a similar manner, the process being repeated until a selected number of bilayers derivatives are formed, the totality of which constitutes a ~~periodic~~ structure of the plasmonic derivatives

(see D2, par. 30: "... The transparent substrate 12 with the fused bimetallic layer 10, 11 can be retracted at a certain speed **in the direction** of the laser beam **13** to selectively generate nanoparticles on the surface of the transparent substrate 12." Movement of the substrate in direction 13 of figure 1 moves the substrate relative to the laser radiation 2.)

D2 does not explicitly state that the nanoparticles generated by laser irradiation form a periodic structure.

The subject-matter of claim 10 therefore differs from this known method in that a periodic structure is formed and is therefore new.

The problem to be solved may be regarded as the provision of a method for generating a certain type of plasmonic sensor.

The solution to this problem is not considered as involving an inventive step for the following reasons:

Plasmonic sensors are mostly formed as periodic structures. The skilled person would readily control the relative movement of the substrate and laser beam in order to obtain a periodic structure. The formation of a periodic structure does therefore not involve an inventive step.

Concluding, claim 10 does not involve an inventive step in view of D2 and common general knowledge.

4 Dependent claims 2-4, 6-9 and 12-13

Dependent claims 2-4, 6-9 and 12-13 do not contain any features which meet the requirements of novelty and/or inventive step:

Claim 2: not novel, see D1, page 012010-6, col. 2, second paragraph "This absorption peak is related to the bimetallic Cu-**Au** core-shell nanospheres."

Claim 3: not novel, see D1, page 012010-6, col. 2, second paragraph, the gold shell is resistant to the oxidation process and protects the copper core.

Claim 4: not inventive, see D1, page 012010-2, col. 2, fourth paragraph disclosing a 50nm thick copper layer and a 50nm gold layer. In order to obtain different proportions of gold and copper in the nanoparticles, the skilled person would change the thickness of the layers without inventive skill.

Claims 6 and 7: not inventive; forming symmetrical or asymmetrical arrays comes within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can readily be foreseen

Claim 8: not novel, see D1, page 012010-2, col. 2, fourth paragraph disclosing borosilicate glass BK7.

Claim 9: not inventive, see D3, page 37383 col. 1, second paragraph, recommending the use of a Titanium adhesion layer.

Claim 12: not inventive, see D1, page 012010-2, col. 2, last paragraph "... ArF laser system ... τ = 15ns". Nanosecond lasers are commonly used in the formation of plasmonic nanostructures.

Claim 13: not inventive, see D2, par. 29 disclosing the control of the average laser power. The skilled person would readily change the laser power when changing the laser beam diameter (as described in par. 30).

5 Positive assessment on novelty and inventive step of dependent claims 5 and 11

The combination of the features of **dependent claims 5 and 11** is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows:

Apparatus **claim 5** differs from D1 in the provision of a convex bilayer shape with an internal cavity.

Correspondingly, method **claim 11** differs from D2 in the formation of a convex bilayer hollow plasmonic derivative.

Prior art documents D1 and D2 disclose the formation of nanoparticles which are filled with material, see D1, page 012010-6, col. 2, second paragraph disclosing Cu-Au core-shell nanospheres and D2, par. 31 "The frozen droplets harden and become nanoparticles 14". D3 merely discloses nanoparticle-like layers (page 37376, col. 1, second paragraph, D3) and is not concerned with forming plasmonic derivatives as defined by the claimed invention.

The cited prior art does not disclose or hint at the formation of bilayer nanostructures with internal cavities. Consequently, the skilled person **would not arrive at the invention as defined in claims 5 and 11.**