IRAQI JOURNAL OF APPLIED PHYSICS

The *Iraqi Journal of Applied Physics (IJAP)* is a peer reviewed journal of high quality devoted to the publication of original research papers from applied physics and their broad range of applications. IJAP publishes quality original research papers, comprehensive review articles, survey articles, book reviews, dissertation abstracts in physics and its applications in the broadest sense. It is intended that the journal may act as an interdisciplinary forum for Physics and its applications. Innovative applications and material that brings together diverse areas of Physics are particularly welcome. Review articles in selected areas are published from time to time. It aims to disseminate knowledge; provide a learned reference in the field; and establish channels of communication between academic and research experts, policy makers and executives in industry, commerce and investment institutions. IJAP is a quarterly specialized periodical dedicated to publishing original papers, letters and reviews in: Applied & Nonlinear Optics, Applied Mechanics & Thermodynamics, Digital & Optical Communications, Electronic Materials & Devices, Laser Physics & Applications, Plasma Physics & Applications, Quantum Physics & Spectroscopy, Semiconductors & Optoelectronics, Solid State Physics & Applications, Alternative and Renewable Energy, and Computers and Networks.

ISSN (Print): 1813-2065, ISSN(Online): 2309-1673, ISSN(Letters): 1999-656X
Impact Factor (2012): 1.1142

Editorial Office:
P. O. Box 55259, Baghdad 12001, IRAQ
info@iraqiphysicsjournal.com, editor_ijap@yahoo.co.uk, editor@ijaponline.com

SPONSORED AND PUBLISHED BY
THE IRAQI SOCIETY FOR ALTERNATIVE AND RENEWABLE ENERGY SOURCES & TECHNIQUES (I.S.A.R.E.S.T.)

www.iraqiphysicsjournal.com, www.ijaponline.com, www.facebook.com/editor.ijap, @IJAP2010, IJAP Editor

IRAQI JOURNAL OF APPLIED PHYSICS

ISSN (Print): 1813-2065, ISSN (Online): 2309-1673, ISSN (Letters): 1999-656X

" INSTRUCTIONS TO AUTHORS "

CONTRIBUTIONS
Contributions to be published in this journal should be original research works, i.e., those not already published or submitted for publication elsewhere, individual papers or letters to editor.
Manuscripts should be submitted to the editor at the mailing address:
Iraqi Journal of Applied Physics, Editorial Board
P. O. Box 55259, Baghdad 12001, IRAQ, editor@iraqiphysicsjournal.com, editor_ijap@yahoo.co.uk

MANUSCRIPTS
Two hard copies with soft copy on a compact disc (CD) should be submitted to Editor in the following configuration:

- **One-column** Double-spaced one-side A4 size with 2.5 cm margins of all sides
- Times New Roman font (16pt bold for title, 14pt bold for names, 12pt bold for headings, 12pt regular for text)
- Letters should not exceed 10 pages, papers should not exceed 20 pages and reviews are up to author.
- Manuscripts presented in English only are accepted.
- English abstract not exceed 150 words
- 4 keywords (at least) should be maintained on (PACS preferred)
- Author(s) should express all quantities in SI units
- Equations should be written in equation form (*italic* and symbolic)
- Figures and Tables should be separated from text
- Figures and diagrams can be submitted in colors for assessment and they will be returned to authors after provide printable copies
- Charts should be indicated by the software used for
- Only original or high-resolution scanner photos are accepted
- For electronic submission, articles should be formatted with MS-Word software.

AUTHOR NAMES AND AFFILIATIONS
It is IJAP policy that all those who have participated significantly in the technical aspects of a paper be recognized as co-authors or cited in the acknowledgments. In the case of a paper with more than one author, correspondence concerning the paper will be sent to the first author unless staff is advised otherwise.
Author name should consist of first name, middle initial, last name. The author affiliation should consist of the following, as applicable, in the order noted:
- Company or college (with department name or company division), Postal address, City, state, zip code, Country name, contacting telephone, and e-mail

REFERENCES
The references should be brought at the end of the article, and numbered in the order of their appearance in the paper. The reference list should be cited in accordance with the following examples:
[1] X. Ning and M.R. Lovell, "On the Sliding Friction Characteristics of Unidirectional Continuous FRP Composites", *ASME J. Tribol.*, 124(1) (2002) 5-13.
[2] M. Barnes, "Stresses in Solenoids", *J. Appl. Phys.*, 48(5) (2001) 2000–2008.
[3] J. Jones, "Contact Mechanics", Cambridge University Press (Cambridge, UK) (2000), Ch.6, p.56.
[4] Y. Lee, S.A. Korpela and R. Horne, "Structure of Multi-Cellular Natural Convection in a Tall Vertical Annulus", Proc. 7th International Heat Transfer Conference, U. Grigul et al., eds., Hemisphere (Washington DC), 2 (1982) 221–226.
[5] M. Hashish, "Waterjet Technology Development", High Pressure Technology, PVP-Vol. 406 (2000), 135-140.
[6] D.W. Watson, "Thermodynamic Analysis", ASME Paper No. 97-GT-288 (1997).
[7] C.Y. Tung, "Evaporative Heat Transfer in the Contact Line of a Mixture", Ph.D. thesis, Rensselaer Polytechnic Institute, Troy, NY (1982).

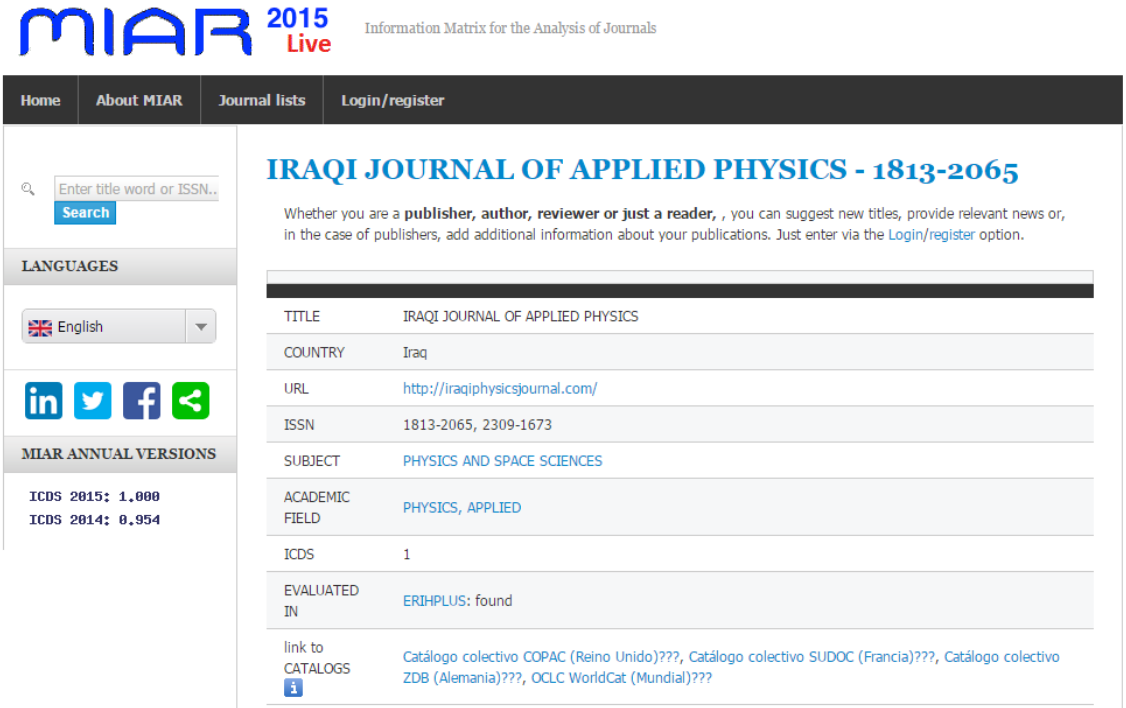
PROOFS
Authors will receive proofs of papers and are requested to return one corrected hard copy with a WORD copy on a compact disc (CD). New materials inserted in the original text without Editor permission may cause rejection of paper.

COPYRIGHT FORM
Author(s) will be asked to transfer copyrights of the article to the Journal soon after acceptance of it. This will ensure the widest possible dissemination of information.

OFFPRINTS
Authors will receive offprints free of charge and any additional reprints can be ordered.

SUBSCRIPTION AND ORDERS
Annual fees (4 issues per year) of subscription are:
50 US$ for individuals inside Iraq; **200** US$ for establishments inside Iraq;
100 US$ for individuals abroad; **300** US$ for establishments abroad.
Fees are reduced by 25% for I.S.A.R.E.S.T. members. Orders of issues can be submitted by contacting the editor-in-chief or editorial office at admin@iraqiphysicsjournal.com, irq_appl_phys@yahoo.com, or editor_ijap@yahoo.co.uk to maintain the address of issue delivery and payment way.

Where you can know about IJAP?



MIAR 2015 Live Information Matrix for the Analysis of Journals

Home | About MIAR | Journal lists | Login/register

Search

LANGUAGES

English

MIAR ANNUAL VERSIONS

ICDS 2015: 1.000
ICDS 2014: 0.954

IRAQI JOURNAL OF APPLIED PHYSICS - 1813-2065

Whether you are a **publisher, author, reviewer or just a reader,** , you can suggest new titles, provide relevant news or, in the case of publishers, add additional information about your publications. Just enter via the Login/register option.

TITLE	IRAQI JOURNAL OF APPLIED PHYSICS
COUNTRY	Iraq
URL	http://iraqiphysicsjournal.com/
ISSN	1813-2065, 2309-1673
SUBJECT	PHYSICS AND SPACE SCIENCES
ACADEMIC FIELD	PHYSICS, APPLIED
ICDS	1
EVALUATED IN	ERIHPLUS: found
link to CATALOGS	Catálogo colectivo COPAC (Reino Unido)???, Catálogo colectivo SUDOC (Francia)???, Catálogo colectivo ZDB (Alemania)???, OCLC WorldCat (Mundial)???

NSD ERIH PLUS EUROPEAN REFERENCE INDEX FOR THE HUMANITIES AND SOCIAL SCIENCES

NSD | Data Services | Software | eLearning | International

NSD DBH

ERIH PLUS
About
Criteria for inclusion
Approval procedures
Revision of ERIH journals
Contact
Search
Help

Registered user
Register new user
Login
Submit new journal

ERIH PLUS
c/o NSD
Harald Hårfagres gate 29
N-5007 Bergen, Norway
Tel +47-55 58 21 17
erihplus@nsd.no

ERIH PLUS

About | Search | Log in | Help

ERIH PLUS REVISION

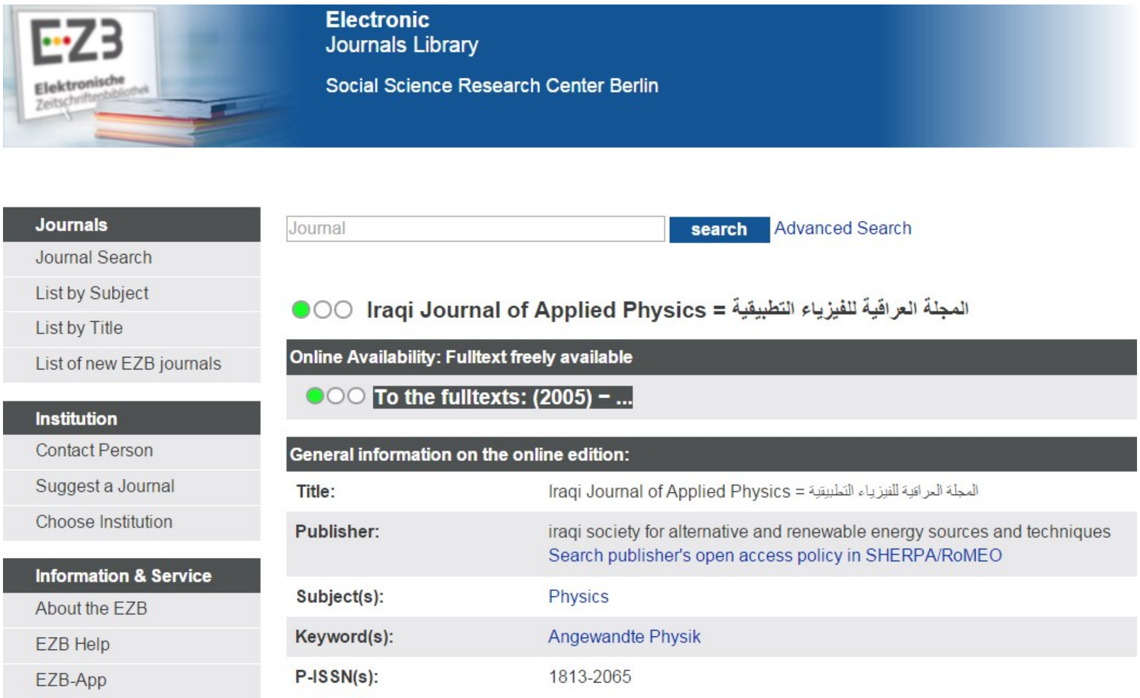
Starting fall 2015 all journals transferred from ERIH to ERIH PLUS will be revised against the ERIH PLUS criteria. The aim of the revision is to ensure that all indexed journals follow the ERIH PLUS standard. During the revision the ERIH PLUS team will collect data about all the journals in order to make this information transparent for the users of the index and too ensure that the information in ERIH PLUS is up to date. In addition to verifying data about the criteria, we will also collect data about language of the publication, country of publication, publisher, open access, whether the publication is national or international, and the website.

All journals transferred from ERIH will regardless of the outcome of the revision still be indexed in ERIH PLUS. The journals will either appear with an updated approval in accordance with the ERIH PLUS criteria or remain approved according to the former ERIH criteria, depending on the findings of the revision. All journals approved in accordance with the ERIH criteria from 2008 or 2011-2012, will with this revision get the opportunity to also be approved in accordance with the ERIH PLUS criteria for inclusion.

Once a journal has been revised an email is sent to the editor of the respective journal. We will use contact information for the journal's editors (or other relevant personnel) that is found by examining the journal's website.

The outcome of the revision is not final, and all journals will be given the chance to provide new information that might affect the result of the revision. This can be done by sending the ERIH PLUS team an email with the relevant documentation and/or direct links to the criterion/criteria in question. If information about the criteria only are to be found in the printed version of the journal, issues can be sent to us by email or to our postal address.

All journals undergoing the ERIH PLUS revision are treated in a standardised way. More information about the ERIH PLUS approval procedures can be found here. Please contact the ERIH PLUS team at erihplus@nsd.no if you have any questions about the ERIH PLUS revision.



EZB Elektronische Zeitschriftenbibliothek

Electronic Journals Library

Social Science Research Center Berlin

Journals
- Journal Search
- List by Subject
- List by Title
- List of new EZB journals

Institution
- Contact Person
- Suggest a Journal
- Choose Institution

Information & Service
- About the EZB
- EZB Help
- EZB-App

Journal | search | Advanced Search

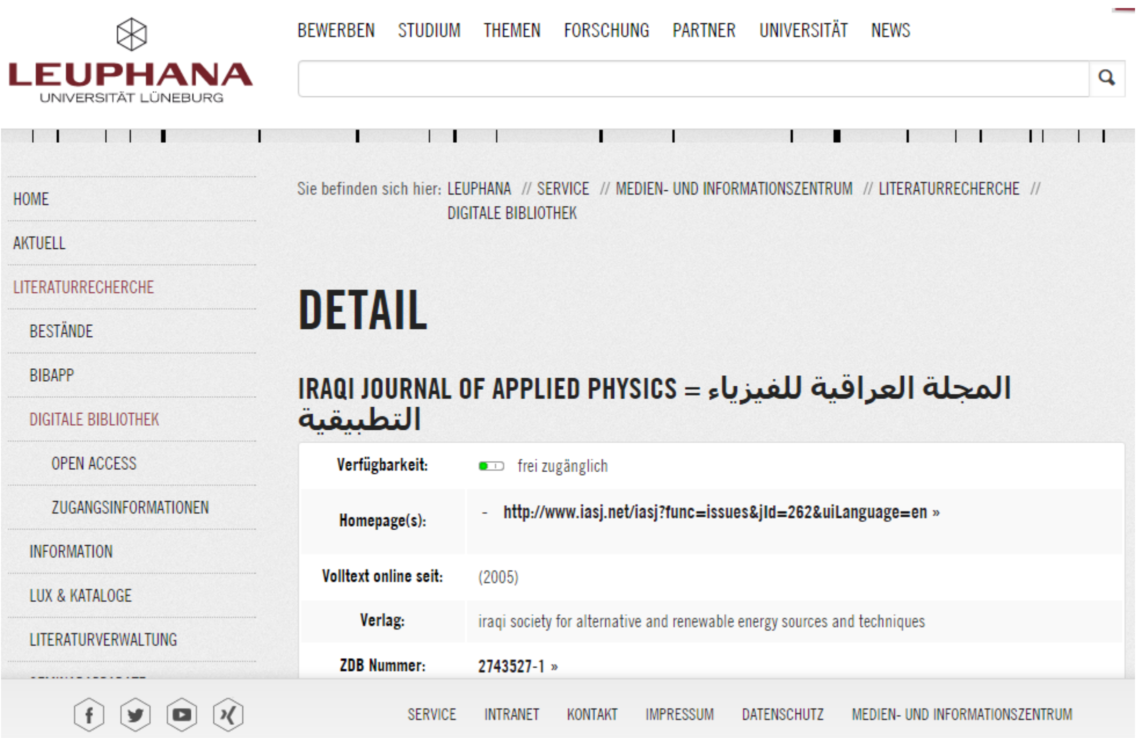
Iraqi Journal of Applied Physics = المجلة العراقية للفيزياء التطبيقية

Online Availability: Fulltext freely available

To the fulltexts: (2005) – ...

General information on the online edition:

Title:	Iraqi Journal of Applied Physics = المجلة العراقية للفيزياء التطبيقية
Publisher:	iraqi society for alternative and renewable energy sources and techniques Search publisher's open access policy in SHERPA/RoMEO
Subject(s):	Physics
Keyword(s):	Angewandte Physik
P-ISSN(s):	1813-2065



LEUPHANA UNIVERSITÄT LÜNEBURG

BEWERBEN STUDIUM THEMEN FORSCHUNG PARTNER UNIVERSITÄT NEWS

- HOME
- AKTUELL
- LITERATURRECHERCHE
  - BESTÄNDE
  - BIBAPP
  - DIGITALE BIBLIOTHEK
    - OPEN ACCESS
    - ZUGANGSINFORMATIONEN
  - INFORMATION
  - LUX & KATALOGE
  - LITERATURVERWALTUNG

Sie befinden sich hier: LEUPHANA // SERVICE // MEDIEN- UND INFORMATIONSZENTRUM // LITERATURRECHERCHE // DIGITALE BIBLIOTHEK

DETAIL

IRAQI JOURNAL OF APPLIED PHYSICS = المجلة العراقية للفيزياء التطبيقية

Verfügbarkeit:	frei zugänglich
Homepage(s):	- http://www.iasj.net/iasj?func=issues&jId=262&uiLanguage=en »
Volltext online seit:	(2005)
Verlag:	iraqi society for alternative and renewable energy sources and techniques
ZDB Nummer:	2743527-1 »

SERVICE INTRANET KONTAKT IMPRESSUM DATENSCHUTZ MEDIEN- UND INFORMATIONSZENTRUM

APS NEWS

Four Elements Added to the Periodic Table

Discoveries made by groups from Russia, Japan, and the U.S. are confirmed

Four new chemical elements will take their places in the periodic table, the International Union of Pure and Applied Chemistry (IPAC) announced last week. IUPAC verified the discoveries of elements 113, 115, 117, and 118, which complete the periodic table's seventh row.

The fourth IUPAC/IUPAP Joint Working Party (JWP) on the priority of claims to the discovery of new elements has reviewed the relevant literature for elements 113, 115, 117, and 118 and has determined that the claims for discovery of these elements have been fulfilled, in accordance with the criteria for the discovery of elements of the IUPAP/IUPAC Transfermium Working Group (TWG) 1991 discovery criteria. These elements complete the 7th row of the periodic table of the elements, and the discoverers from Japan, Russia and the USA will now be invited to suggest permanent names and symbols. The new elements and assigned priorities of discovery are as follows:

Element 113 (temporary working name and symbol: ununtrium, Uut)
The RIKEN collaboration team in Japan have fulfilled the criteria for elementZ=113 and will be invited to propose a permanent name and symbol.

Elements 115, 117, and 118 (temporary working names and symbols: ununpentium, Uup; ununseptium, Uus; and ununoctium, Uuo)
The collaboration between the Joint Institute for Nuclear Research in Dubna, Russia; Lawrence Livermore National Laboratory, California, USA; and Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA have fulfilled the criteria for element Z=115, 117 and will be invited to propose permanent names and symbols.

The collaboration between the Joint Institute for Nuclear Research in Dubna, Russia and Lawrence Livermore National Laboratory, California, USA have fulfilled the criteria for element Z=118 and will be invited to propose a permanent name and symbol.

The priorities for four new chemical elements are being introduced simultaneously, after the careful verification of the discoveries and priorities. The decisions are detailed in two reports by the Joint Working Party (JWP), which includes experts drawn from IUPAC and IUPAP (the International Union of Pure and Applied Physics). These reports will be published in an early 2016 issue of the IUPAC journal Pure and Applied Chemistry (PAC).The JWP has reviewed the relevant literature pertaining to several claims of these new elements. The JWP has determined that the RIKEN collaboration have fulfilled the criteria for the discovery of element with atomic numbers Z=113. Several studies published from 2004 to 2012 have been construed as sufficient to ratify the discovery and priority.
In the same *PAC* report, the JWP also concluded that the collaborative work between scientists from the Joint Institute for Nuclear Research in Dubna, Russia; from Lawrence Livermore National Laboratory, California, USA; and from Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA (the Dubna-Livermore-Oak Ridge collaborations), starting in 2010, and subsequently confirmed in 2012 and 2013, have met the criteria for discovery of the elements with atomic numbers$Z$=115 and Z=117.
Finally, in a separate *PAC* article the Dubna�Livermore collaboration started in 2006 is reported as having satisfied the criteria for discovery of element Z=118.
"A particular difficulty in establishing these new elements is that they decay into hitherto unknown isotopes of slightly lighter elements that also need to be unequivocally identified� commented JWP chair Professor Paul J. Karol, �but in the future we hope to improve methods that can directly measure the atomic number, Z".

 ISSN (printed) 1813-2065, (online) 2309-1673

"The chemistry community is eager to see its most cherished table finally being completed down to the seventh row. IUPAC has now initiated the process of formalizing names and symbols for these elements temporarily named as ununtrium, (Uut or element 113), ununpentium (Uup, element 115), ununseptium (Uus, element 117), and ununoctium (Uuo, element 118)" said Professor Jan Reedijk, President of the Inorganic Chemistry Division of IUPAC.

The proposed names and symbols will be checked by the Inorganic Chemistry Division of IUPAC for consistency, translatability into other languages, possible prior historic use for other cases, etc. New elements can be named after a mythological concept, a mineral, a place or country, a property or a scientist (see: W.H. Koppenol, *PAC* 74 (2002) 787-791). After Divisional acceptance, the names and two-letter symbols will be presented for public review for five months, before the highest body of IUPAC, the Council, will make a final decision on the names of these new chemical elements and their two-letter symbols and their introduction into the Periodic Table of the Elements.

"As the global organization that provides objective scientific expertise and develops the essential tools for the application and communication of chemical knowledge for the benefit of humankind, the International Union of Pure and Applied Chemistry is pleased and honored to make this announcement concerning elements 113, 115, 117, and 118 and the completion of the seventh row of the periodic table of the elements," said IUPAC President Dr. Mark C. Cesa, adding that, "we are excited about these new elements, and we thank the dedicated scientists who discovered them for their painstaking work, as well the members of the IUPAC/IUPAP Joint Working Party for completing their essential and critically important task."

Element 113

Element 113 was discovered by a collaboration at RIKEN in Japan, and elements 115 and 117 were discovered by a collaboration between the Joint Institute for Nuclear Research in Dubna, Russia, Lawrence Livermore National Laboratory, and Oak Ridge National Laboratory. Element 118 was discovered by a collaboration between the Joint Institute for Nuclear Research and Lawrence Livermore. The collaborations will be given naming rights for the new elements.

The following papers published in APS journals helped clinch the case for discovery of the various elements:

Element 115

Experiments on the synthesis of element 115 in the reaction ^{243}Am (^{48}Ca,xn) $^{291-x}$115

Yu. Ts. Oganessian *et al.*

Phys. Rev. C 69, 021601(R) – Published 2 February 2004

Abstract

The results of experiments designed to synthesize element 115 isotopes in the ^{243}Am+^{48}Ca reaction are presented. With a beam dose of 4.3×10^{18} 248−MeV ^{48}Ca projectiles, we observed three similar decay chains consisting of five consecutive α decays, all detected in time intervals of about 20s and terminated at a later time by a spontaneous fission with a high-energy release (total kinetic energy ~220MeV). At a higher bombarding energy of 253MeV, with an equal ^{48}Ca beam dose, we registered a different decay chain of four consecutive α decays detected in a time interval of about 0.5s, also terminated by spontaneous fission. The α decay energies and half-lives for nine new α-decaying nuclei are given. The decay properties of these synthesized nuclei are consistent with consecutive α decays originating from the parent isotopes of the new element 115, ^{288}115 and ^{287}115, produced in the 3n- and 4n-evaporation channels with cross sections of about 3pb and 1pb, respectively. The radioactive properties of the new odd-Z nuclei (105–115) are compared with the predictions of the macroscopic-microscopic theory. The experiments were carried out at the U400 cyclotron with the recoil separator DGFRS at FLNR, JINR.

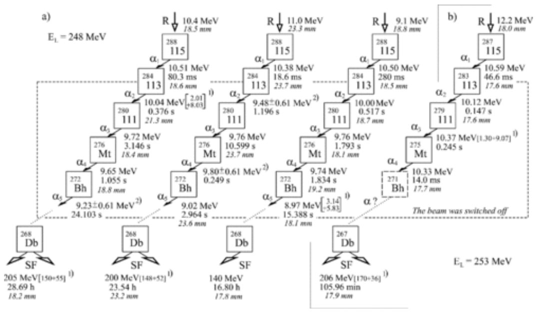


Fig. (1) Time sequences in the decay chains observed at two ^{48}Ca energies EL=248MeV (a) and EL=253MeV (b). Measured energies, time intervals, and vertical positions with respect to the top of the strips of the observed decay events are shown. (1) Energies of events detected by both the focal-plane detector and side detectors. (2) Energies of events detected by side detectors only. We have inserted an unobserved nuclide in the fourth decay chain.

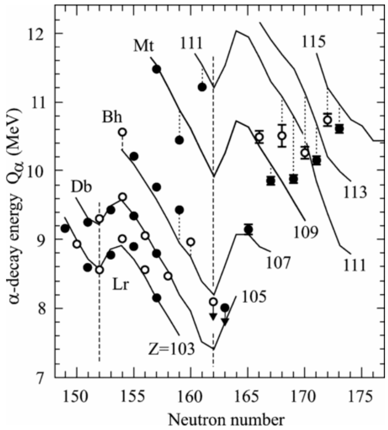


Fig. (2) α-decay energy vs neutron number for isotopes of odd-Z elements (solid circles, odd-odd isotopes; open circles, odd-even isotopes). Solid lines show theoretical Qα values. Data at N⩾162 are from the present work. Upper Qα limits for ^{267}Db and ^{268}Db were calculated assuming a hindrance factor of 3 (circles with arrows).

Element 117

Synthesis of a New Element with Atomic Number Z=117

Yu. Ts. Oganessian *et al.*

Phys. Rev. Lett. 104, 142502 – Published 9 April 2010

Abstract

The discovery of a new chemical element with atomic number Z=117 is reported. The isotopes ^{293}117 and ^{294}117 were produced in fusion reactions between ^{48}Ca and ^{249}Bk. Decay chains involving 11 new nuclei were identified by means of the Dubna gas-filled recoil separator. The measured decay properties show a strong rise of stability for heavier isotopes with Z≥111, validating the concept of the long sought island of enhanced stability for superheavy nuclei.

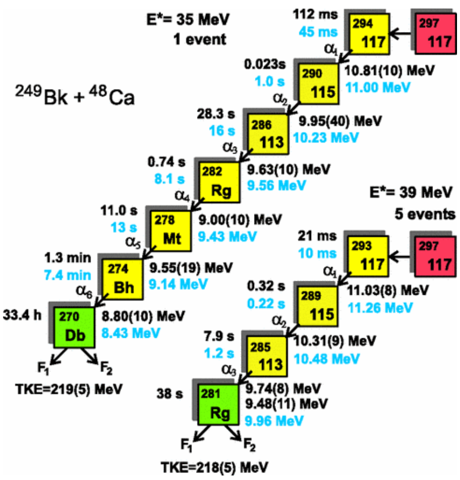


Fig. (1) Observed decay chains interpreted as originating from the isotopes A=294 (single event) and A=293 (average of five events) of the new element Z=117. The deduced and predicted lifetimes (τ=T$_{1/2}$/ln2) and α-particle energies are shown in black and blue, respectively.

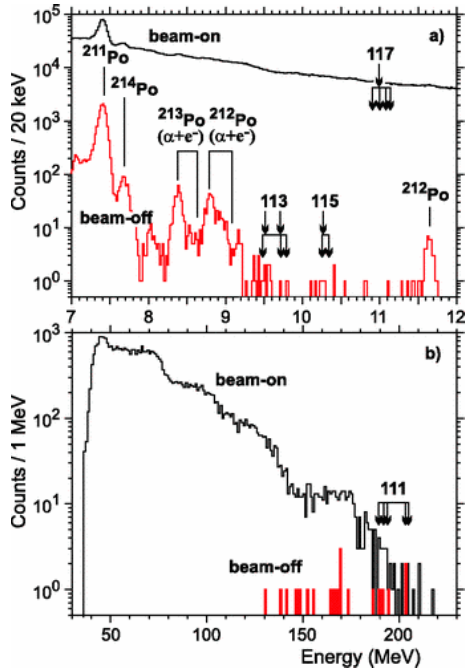


Fig. (2) Energy spectra recorded during the 252 MeV ^{48}Ca+^{249}Bk run (E*=39 MeV). (a) Total energy spectra of beam-on α-like signals and beam-off αparticles. (b) Total fission-fragment energy spectra, both beam on and beam off. The arrows show the energies of events observed in the correlated decay chains; see Fig. (1).

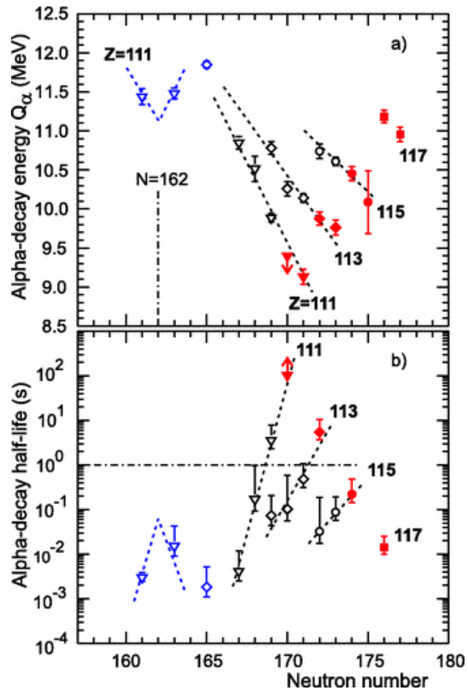


Fig. (3) (a) α-decay energy and (b) half-lives versus neutron number for the isotopes of elements with Z=111–117 (new results in red). All the nuclides with N>165 have been produced in ^{48}Ca induced reactions. Our T$_{\alpha}$(exp) values are given for the nuclei belonging to the $^{293}117$ decay chain (5 events). The limit for $T_{\alpha}(^{281}Rg)$ was estimated from the measured half-life and number of observed nuclei.

Element 118

Synthesis of the isotopes of elements 118 and 116 in the ^{249}Cf and ^{245}Cm+^{48}Ca fusion reactions

Yu. Ts. Oganessian *et al.*

Phys. Rev. C 74, 044602 – Published 9 October 2006

Abstract

The decay properties of 290116 and 291116, and the dependence of their production cross sections on the excitation energies of the compound nucleus, $^{293}116$, have been measured in the ^{245}Cm (^{48}Ca, xn) $^{293-x}116$ reaction. These isotopes of element 116 are the decay daughters of element 118 isotopes, which are produced via the ^{249}Cf+^{48}Ca reaction.

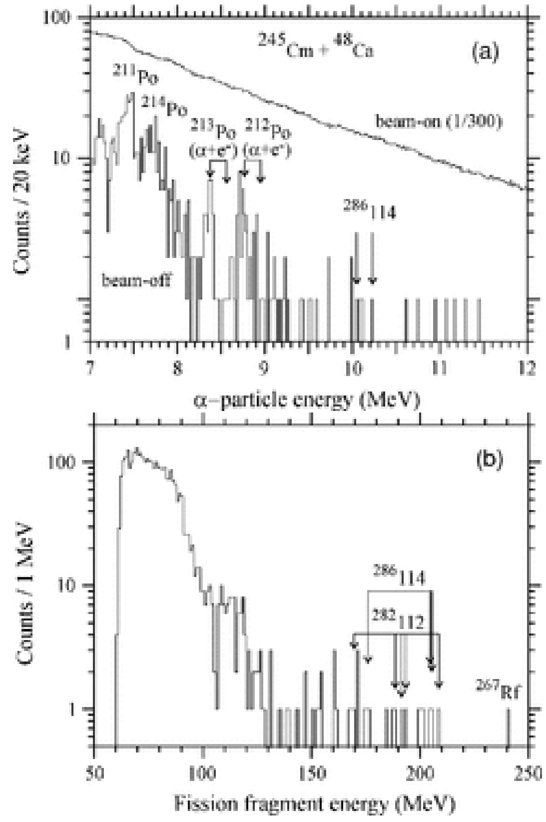


Fig. (1) (a) Total beam-on and beam-off α-particle energy spectra of events registered by the focal-plane detector and by both the focal-plane and side detectors in the ^{245}Cm+^{48}Ca reaction. In the beam-off α-particle spectrum we observe the peaks originating from isotopes of Po, the decay products of long-lived isotopes of Ra-Th produced in transfer reactions, and ^{211}Po, the descendant nucleus of ^{219}Th produced in the calibrations with a ^{nat}Yb target. The energies of events observed during beam-off periods in the correlated decay chains are shown by arrows. (b) Total fission-fragment energy spectrum in the ^{245}Cm+^{48}Ca reaction; the arrows show the energies of events observed in the correlated decay chains.

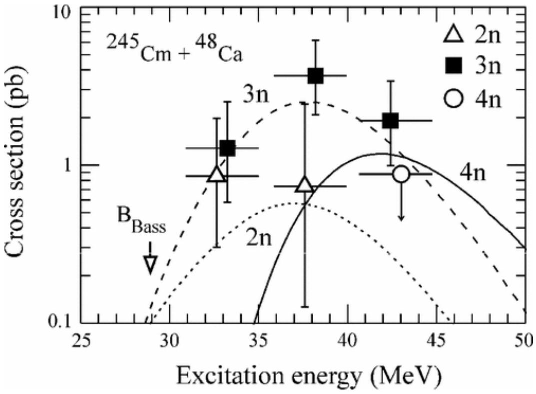


Fig. (2) Excitation functions for the 2*n*, 3*n*, and 4*n* evaporation channels from the complete-fusion reaction ^{245}Cm+^{48}Ca. The Bass barrier is shown by an open arrow. Lines show the results of theoretical predictions. Error bars correspond to statistical uncertainties.

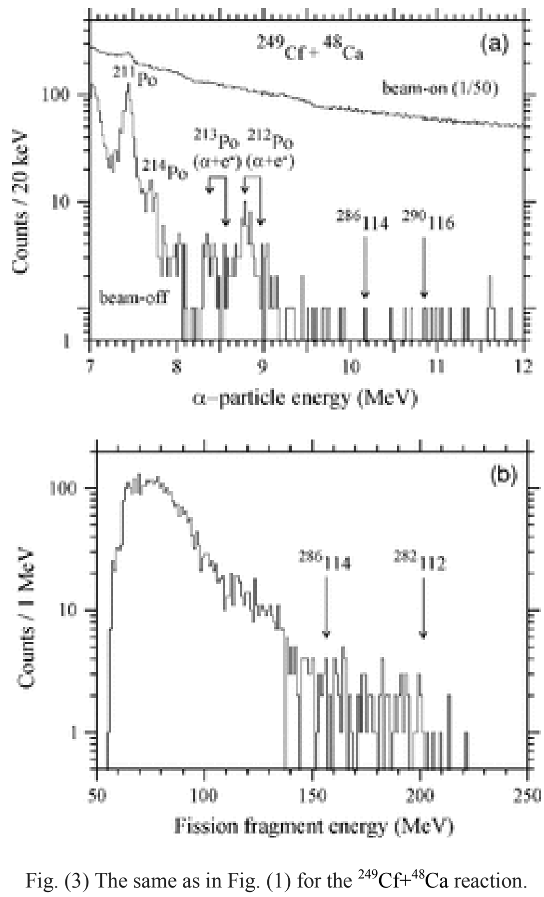


Fig. (3) The same as in Fig. (1) for the ^{249}Cf+^{48}Ca reaction.

We performed the element 118 experiment at two projectile energies, corresponding to $^{297}118$ compound nucleus excitation energies of E^{*}=29.2±2.5 and 34.4±2.3 MeV. During an irradiation with a total beam dose of 4.1×10^{19} ^{48}Ca projectiles, three similar decay chains consisting of two or three consecutive α decays and terminated by a spontaneous fission (SF) with high total kinetic energy of about 230 MeV were observed. The three decay chains originated from the even-even isotope $^{294}118$ (E_α=11.65±0.06 MeV, $T_\alpha = 0.89^{+1.07}_{-0.31}$ ms) produced in the 3n-evaporation channel of the ^{249}Cf+^{48}Ca reaction with a maximum cross section of $5^{+1.6}_{-0.3}$ pb.

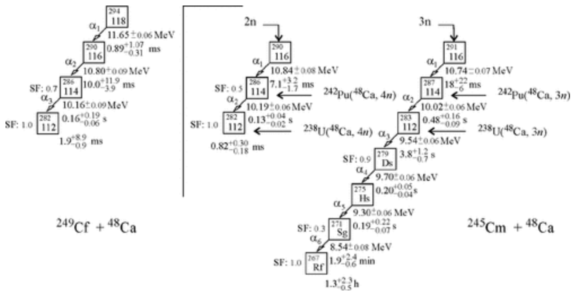


Fig. (4) Time sequences in the decay chains of ^{294}118 (left), ^{290}116 (middle), and ^{291}116 (right) observed in the ^{249}Cf+^{48}Ca and ^{245}Cm+^{48}Ca reactions. The nuclei observed in cross bombardments of ^{242}Pu and ^{238}U by ^{48}Ca are shown by arrows. The average measured α-particle energies, half-lives, and SF branching ratios of the observed nuclei are shown separately for three decay chains of ^{294}118 and all nuclei in the chains originating from parent isotopes ^{290}116 and ^{291}116.

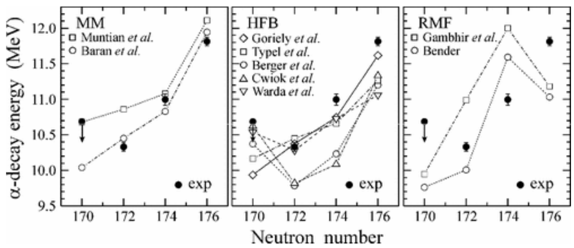


Fig. (5) α-decay energy vs. neutron number for isotopes in the decay chain originating from ^{294}118. Solid circles show the experimental data. The value shown for ^{282}112 is an upper limit, since this nuclide has not been observed to decay by α-emission. Open symbols connected by lines show the theoretical Q_α values calculated for the same isotopes in the MM (squares, circles), HFB (diamonds, squares, circles, triangles up, triangles down) and RMF (squares, circles) models.

SPIE. CONNECTING MINDS. ADVANCING LIGHT.

Unusual Photonic States Demonstrated by Modulating Dirac Points

Bo Zhen
Research Laboratory of Electronics, Department of Physics, Massachusetts Institute of Technology (MIT), Cambridge, MA

Chia Wei Hsu
Department of Applied Physics, Yale University, New Haven, CT

John D. Joannopoulos, Marin Soljačić
Department of Physics, MIT, Cambridge, MA

A continuous ring of singularities called exceptional points can be generated from a Dirac cone in a 3D photonic crystal slab, with potential applications in optical devices.

28 December 2015, SPIE Newsroom. DOI: 10.1117/2.1201511.006168

According to the textbook definition, the eigenspace of a Hermitian operator always forms a complete basis, as shown schematically in Figure 1(a). In contrast, the question of which non-Hermitian operators have an eigenspace that does not form a complete basis is more complicated. The answer is: when there are exceptional points (EPs). EPs are singularities that are unique to non-Hermitian systems,[1, 2] where two or more eigenvectors merge into one with the same complex eigenvalue: see Figure 1(b). Since their introduction into optics and photonics,[3] EPs have given rise to many interesting and counterintuitive physical phenomena, including loss-induced transparency[4] and unidirectional reflection.[5]

A seemingly unrelated phenomenon is the Dirac cone, which originated in high-energy and particle physics and has recently also become important in the physics of condensed matter and materials science. Its characteristic band structure comprises two conical bands that touch at a single point, as shown in Figure 2(a). This has been achieved in various systems, including single layers of carbon atoms (graphene), cold atoms in optical lattices, and coupled optical waveguide arrays, as well as, recently, via accidental degeneracy.[6] In fact, Dirac cones and EPs are connected. It has been suggested[3, 7,8] that in theory certain systems can deform a Dirac cone into a ring of EPs, or an 'exceptional ring.' However, an experimental demonstration of this process has not been achieved until now.[9]

A 2D photonic crystal[10] is a Hermitian system, which is a closed system without gain or loss of energy. Here, we consider a photonic crystal consisting of a square lattice of airholes in a background with a high refractive index: see the inset of Figure 2(a). By varying the radii of the holes, we can obtain a Dirac cone by means of accidental degeneracy,[6] as shown in Figure 2(a). However, if we consider a similar system—a 3D photonic crystal slab of finite thickness—this is not Hermitian, because the energy in the system can leak out by radiating toward the top or bottom of the slab: see the inset of Figure 2(b). Consequently, the dispersion of the system changes completely: the conical dispersion disappears, to be replaced by an exceptional ring, as shown in Figure 2(b).

To demonstrate this effect, we fabricated a photonic crystal slab with a large area[11] in accordance with the theoretical design. We performed measurements of angle-resolved reflectivity on this sample under different polarizations of light. A detailed analysis of the spectrum that we recorded yields parameters of the effective non-Hermitian Hamiltonian, which provides the complex eigenvalues of the system. Our results show that the complex eigenvalues become almost degenerate along both directions in momentum space that we measured, which confirms that an exceptional ring is present in our system.

Our results also demonstrate that our system exhibits the interesting phenomenon of coupled-resonator-induced transparency (CRIT). When a resonator is coupled to a waveguide that is otherwise perfectly transmissive, light can be totally reflected at the resonance frequency ω_0 as a result of on-resonance coupling. When two coupled resonators are coupled to the same waveguide, light can be totally reflected at both resonance frequencies ω_1 and ω_2. Surprisingly, a transparency frequency can occur between ω_1 and ω_2, where light is fully transmitted with no reflection: this is referred to as CRIT.[12] We observed CRIT between two large-area Bloch modes of photonic crystal slabs. This phenomenon has the potential to be useful in large-area narrow-band filters.

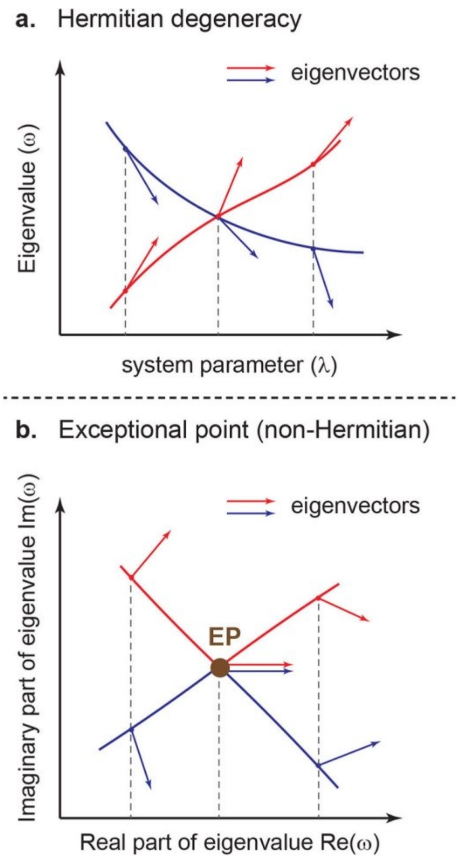


Fig. (1) A comparison of Hermitian and non-Hermitian degeneracy. (a) Eigenvectors belonging to two distinct eigenvalues (red and blue lines) of a Hermitian operator are shown as red and blue arrows. Even when degenerate (where the red and blue lines cross), the eigenvectors are orthogonal and form a complete basis. (b) The corresponding eigenvectors close to a non-Hermitian degeneracy called an exceptional point (EP) (shown as the brown circle) are also shown as red and blue arrows. The eigenvectors at the EP merge and no longer form a complete basis.

In pure physics, our method of generating an exceptional ring could be extended to other Dirac systems, such as electrons in graphene and cold atoms. By further study, we could advance our understanding of the connection between the topological properties of Dirac cones and those of EPs. Our work also provides a simple method of testing the properties of EPs and applying these to improve optical devices. For example, it would be of great interest to realize proposals to exploit the unusual square-root dispersion around EPs to manufacture single-particle detectors.[13] Also, by applying EPs in photonic-crystal surface-emitting lasers,[14] we should be able to enlarge the lasing area while keeping the laser in single mode and therefore further increase the output power.

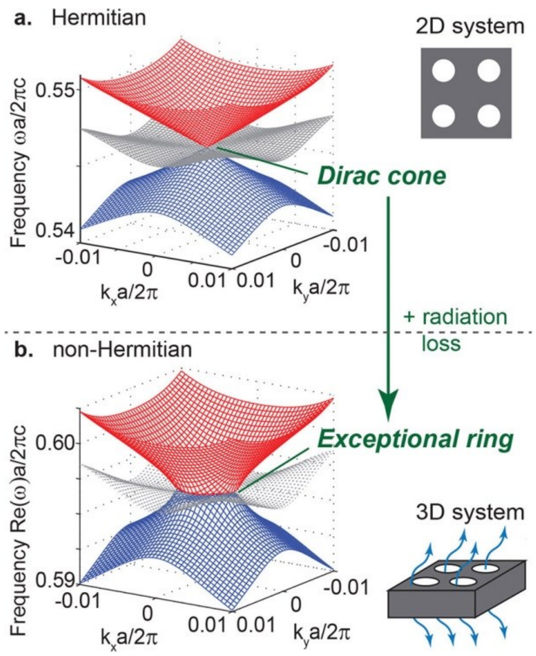


Fig. (2) Deformation of a Dirac cone into an exceptional ring. (a) In a Hermitian system (a 2D photonic crystal), a Dirac cone can be produced via accidental degeneracy by varying the radius of the airhole. This is shown by the blue and red conical dispersions that touch at a single point. (b) A very similar 3D photonic crystal slab is no longer Hermitian, because energy can leak out via radiation. Consequently, the dispersion also changes dramatically: the tip of the cone is flattened and gives rise to a ring of EPs, or an exceptional ring. a: Lattice constant. k_x and k_y: Wave vectors in the x and y directions.

References:

1. T. Kato, *Perturbation Theory for Linear Operators 2nd ed.*, Springer, Berlin, 1995.
2. N. Moiseyev, *Non-Hermitian Quantum Mechanics*, Cambridge University Press, 2011.
3. K.G. Makris et al., *Phys. Rev. Lett.* 100(10), p. 103904, 2008.
4. A. Guo et al., *Phys. Rev. Lett.* 103(9), p. 093902, 2009.
5. Z. Lin et al., *Phys. Rev. Lett.*106(21), p. 213901, 2011.
6. X. Huang et al., *Nat. Mater.* 10(8), p. 582-586, 2011.
7. M.V. Berry, *Czech. J. Phys.* 54, p. 1039-1047, 2004.
8. A. Szameit et al., *Phys. Rev. A* 84(2), p. 021806, 2011.
9. B. Zhen et al., *Nature*525, p. 354-358, 2015.
10. J.D. Joannopoulos et al., *Photonic Crystals: Molding the Flow of Light 2nd ed.*, Princeton University Press, 2008.
11. J. Lee et al., *Phys. Rev. Lett.* 109(6), p. 067401, 2012.
12. C.W. Hsu et al., *Nano Lett.* 14(5), p. 2783-2788, 2014.
13. J. Wiersig, *Phys. Rev. Lett.* 112(20), p. 203901, 2014.
14. K. Hirose et al., *Nat. Photonics* 8(5), p. 406-411, 2014.

SPIE. CONNECTING MINDS. ADVANCING LIGHT.

Digital Liquid Lens for Fast Scanning Technologies

C. W. Gary Tsai
Lustrous Electro-Optics Inc., Hsinchu, Taiwan

A robust lens, with rapid focus response and high diopter range, is used in a prototype touchless fingerprint sensor.

31 December 2015, SPIE Newsroom. DOI: 10.1117/2.1201512.006209

Variable-focus liquid lenses have recently been exploited in compact camera modules to enhance autofocusing capabilities.[1–3] Widespread adoption of these lenses in the manufacture of cellphone camera modules (CCMs) currently looks unlikely, however, because an alternative technology—voice coil motors—is already dominant in the CCM market. To find other suitable applications for variable-focus liquid lenses, we have recognized the need to tailor the lenses to unique device specifications.

One example application of variable-focus liquid lenses is for 2D barcode readers, in which the lenses have millisecond response times and several million operation cycles.[4] Most liquid lens devices operate in analog mode because of specific design limitations, where hysteresis is pertinent in the responses. The set focus essentially depends on the amplitude of the applied voltage (i.e., similar to a mass–spring mechanical system). The focus response is therefore initially fast, but slow near to the target because of reduced driving forces. A problematic phenomenon, however, is that response times for small focus changes are greater than for larger focus changes.

To enable further applications, we have been developing liquid lenses (see Figure 1) with focal range greater than 40 diopters, tens of millions of operation cycles, and digital switching times of 5ms. Based on these lenses, we have developed a prototype touchless fingerprint sensor. The liquid lens that we report here has a robust double O-ring mechanical structure—see Figure 2(a)—and operates in digital mode.

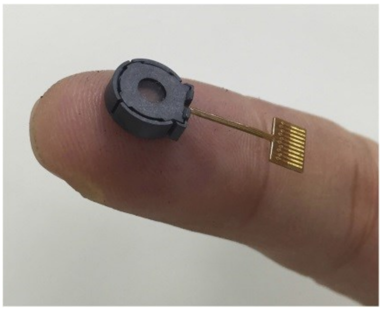


Figure 1. A digital liquid lens with nine digital steps in its focus range.

With our digital liquid lens, we are able to overcome the problematic response time issue associated with conventional analog devices. We achieve this by applying an over-scale voltage at the beginning, and by switching back to the setting voltage when the focus is close to the target value.[5] This method, however, is complex, and difficult to implement in practical applications. Therefore, we have devised a simple digital operation mode with which we achieve fast response times[6] by applying an alternating voltage into the liquid during the focus-switching period. We apply another alternating voltage—with a π lagging phase—into the electrodes, from the initial location of a tri-phase line of oil droplets that leads to the target electrode. The tri-phase interface then reaches the target electrode, which needs only the holding voltage to maintain the position of the oil droplet at the target focus.

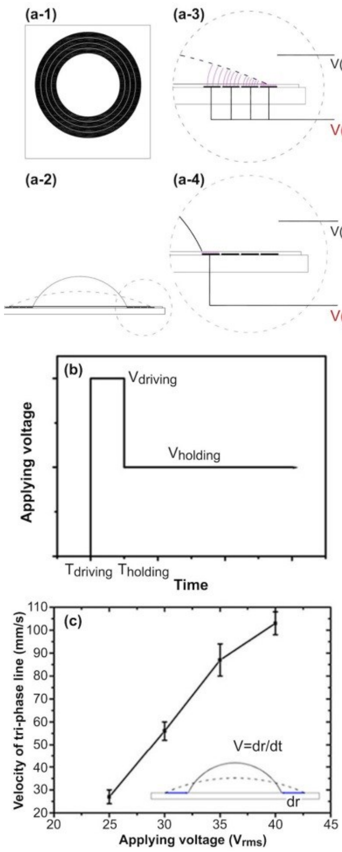


Figure 2. (a-1) The concentric annulus electrode structure used in the digital liquid lens setup. (a-2) Cross section of a digital liquid lens. (a-3) Applying voltage, V(ϕ), and voltage with a πlagging phase, V(ϕ–π), during the focus-switching period. (a-4) Applying voltage during the focus-holding period. (b) Model of voltage application. $V_{holding}$: Holding voltage. $V_{driving}$: Driving voltage. $T_{holding}$: Holding time. $T_{driving}$: Driving time. (c) Relationship between applied voltage and velocity (V) of a tri-phase line of oil droplets. r: Radius of oil droplets. t: Time.

We intentionally set a high applied voltage so that we obtain a fast focus response with a low holding voltage. This prevents failure in the dielectric layer, as shown in Figure 2(b). The pattern of the high-driving and low–holding voltage gives rise to a fast switching speed and a long operation cycle as the optimal driving pattern. The advancing speed of the tri-phase line versus the amplitude of the applied voltage—see Figure 2(c)—indicates that the focus switching time can be less than 3ms in the digital liquid lens when the over–driving voltage is 30V root mean square.

As well as achieving a fast focusing response with our liquid lens, we are also able to achieve auto-centering in the optical axis and no hysteresis in the focus loop. Furthermore, our liquid lens enables fabrication variance. This is in contrast to analog lenses, in which the focal length is altered (for example) by changing the thickness of the insulation layer in the substrate. Our lens benefits from an easy-control algorithm and interfaces with custom-designed integrated circuits.

To achieve a reliable seal during the assembly process, we used a double O-ring mechanical structure for the liquid lens packaging (see Figure 3).[7] If the seal were to fail during operation, the liquids inside the lens would leak out and evaporate, and thus generate an air bubble in the lens. An outer O-ring with a small diameter absorbs the thermal volume expansion of the liquid if the ambient temperature increases, and vice versa (see Figure 3). Without this outer O-ring, the liquid pressure would increase because of volumetric thermal expansion. The leak between the inner O-ring (with a larger diameter) and the glass would therefore increase, as would the length of the cycle time (under the high ambient temperature). We have empirically calculated that a liquid lens with a single O-ring would exhibit a bubble soon after 24 hours at 65°C, whereas the liquid lens with a double O-ring could last more than two weeks under the same conditions.

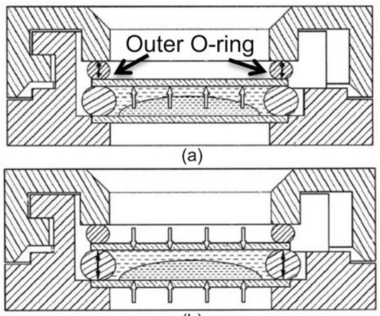


Figure 3. *Schematic of the double O-ring structure of the liquid lens. (a) Liquid volume expansion caused by environmental temperature increase. (b) Liquid volume contraction caused by temperature decrease.*

We have used fast z-axis scanning of our digital liquid lens to develop a prototype touchless fingerprint sensor.[8] The fast focus response and high diopter range of our lens enable scanning of the focal plane—with a 2 million-pixel (2M) CCM—from 3 to 1cm, in 40ms. We can therefore resolve the limited depth of field problem in macro photography. To use our device, one holds a finger above the sensor to capture a fingerprint image. The sensor, with a scanned picture, and recognized features of a fingerprint are shown in Figure 4. These results indicate that the macro photograph picture area is larger than the dimension of the sensor.

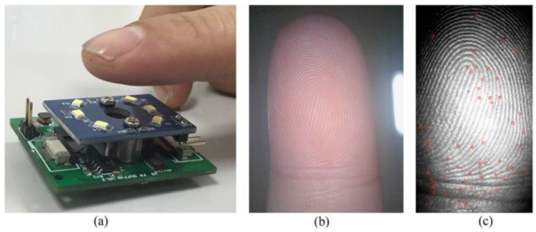


Figure 4. *A touchless fingerprint sensor based on z-axis scanning of the digital liquid lens. (a) The prototype module. (b) Captured color picture of a fingerprint. (c) Recognized fingerprint picture with marked minutiae.*

We have developed a liquid lens that has a digital operation mode and a double O-ring structure. We have realized a touchless fingerprint sensor prototype with this lens. Based on this work, it is possible that fast-focus scanning technology could be introduced to facial recognition cameras, focus stacking in microscopy (i.e., multiple images taken at different focus distances to obtain an image with a greater depth of field), and macro 3D photography.[3, 9] Ultimately, our digital liquid lens could be embedded into the autofocus of camera arrays.[10] We are continuing to improve our digital liquid lens, with a particular focus on its reliability and manufacturability. Our next step will be to seek partners to develop new applications of our lens.

References:

1. http://www.varioptic.com Varioptic, a developer of liquid lens technology. Accessed 30 October 2015.
2. C. Graetzel, M. Suter, M. Aschwanden, Reducing laser speckle with electroactive polymer actuators, *Proc. SPIE* 9430, p. 943004, 2015. doi:10.1117/12.2086088
3. P. Novak, J. Novak, A. Miks, Analysis and application of refractive variable-focus lenses in optical microscopy, *Proc. SPIE* 8083, p. 808316, 2011. doi:10.1117/12.889546
4. www.cognex.com/liquid-lens.aspx Cognex liquid lens technology. Accessed 30 October 2015.
5. B. Burger, S. C. Meimon, C. Petit, M. C. Nguyen, Improvement of Varioptic's liquid lens based on electrowetting: how to obtain a short response time and its application in the design of a high resolution iris biometric system, *Proc. SPIE* 9375, p. 93750S, 2015.doi:10.1117/12.2075719
6. C.-W. Tsai, Liquid lens driving method, *US Patent* US20140307330, 2014.
7. C.-W. Tsai, J.-Y. Chung, Liquid lens package structure, *US Patent* US9052451, 2015.
8. C. W. Tsai, P. J. Wang, J. A. Yeh, Compact touchless fingerprint reader based on digital variable-focus liquid lens, *Proc. SPIE* 9193, p. 91930M, 2014. doi:10.1117/12.2061205
9. M. Martínez-Corral, P.-Y. Hsieh, A. Doblas, E. Sánchez-Ortiga, G. Saavedra, Y.-P. Huang, Fast axial-scanning widefield microscopy with constant magnification and resolution,*J. Display Technol.* 11, p. 913-920, 2015.
10. L. Smeesters, G. Y. Belay, H. Ottevaere, Y. Meuret, M. Vervaeke, J. Van Erps, H. Thienpont, Proof-of-concept demonstration of a miniaturized multi-resolution refocusing imaging system using an electrically tunable lens, *Proc. SPIE* 9192, p. 91920G, 2014.doi:10.1117/12.2061296

IHS **Engineering**360

Next-Generation Polymer for Automotive Applications

Robert Springer

01 December 2015

Polymer coatings like Teflon are an established technology, and generally adhere well to many types of products. Yet the way that the coatings are applied and cured can limit their utility in some applications.

A Boston-based company has developed a method to allow commercially available polymers to more efficiently coat many types of products, including tire molds and electronic circuit boards. GVD Corp. has received funding from an interesting mix of government agencies, including the U.S. Environmental Protection Agency (EPA) and the Departments of Defense and Health and Human Services.

The traditional approach to polymer application involves mixing it with a solvent (which acts as a dispersing agent) and then spraying or dipping it onto an item. The now-wet item must be cured using ultraviolet light or baked at a high temperature [more than 700 degrees Fahrenheit with polytetrafluoroethylene (PTFE or Teflon)], according to Hilton Pryce Lewis, CEO.

This process, called “spray-and-bake” by Lewis, “is a crude, inefficient process that tends to produce thick, non-conformal coatings.” The necessity of a high-heat curing step limits the items that can be coated. “So, on the one hand you have a highly controlled chemical reaction to produce an exquisitely well-defined bulk material, but then you apply it as a coating using pretty crude methods.”

Solvent-Free Polymer Coating

Solvents are a good-news, bad-news part of the polymer equation. While they allow polymers to be dispersed in a solution for application, it’s difficult for the polymer to disperse evenly enough to coat a tire mold, for example, or any other product with fine features.

Additional issues include chemical damage to the item itself or the underlying layers of coating and the environmental impacts of usage, including product disposal and exposure to workers who are applying it. Pryce Lewis analogized poorly dispersed polymers to lumpy oatmeal, as some parts may receive too much coating while others don’t get enough.

To overcome the negative effects of solvents, GVD created a “dry” process for applying polymers. “It gets you away from the effects of surface tension, where you get pooling in corners and potential damage to very sensitive parts as the solvent dries,” says Pryce Lewis.

The EPA recognized the benefits of GVD’s solvent-free approach and awarded the company a Small-Business Innovative Research (SBIR) grant to continue developing its coating process for mold release application, says Pryce Lewis.

A New Way to Deposit Polymers

GVD calls its polymer deposition process iCVD (Initiated Chemical Vapor Deposition), which was developed by Karen Gleason, an associate provost at the Massachusetts Institute of Technology as well as a founder and chief scientific advisor for GVD. The premise of iCVD was to combine the advances in our understanding of polymer chemistry with the advances in deposition processes that have occurred over the last several decades, says Pryce Lewis. “To take polymer chemistry into the gas phase, as it were,” he says.

Unlike with the traditional coating process, iCVD allows GVD to make the polymer directly on the surface of the part that needs to be coated. “In our process, you’re starting with a monomer, not a polymer, and creating conditions that allow the polymerization reaction to occur when you want it, where you want it,” he says. That’s the ‘C’ part of iCVD – chemical vapor deposition. “The result is much greater versatility in the chemistry of the resulting coatings, the range of parts that can be coated and the breadth of new applications that can be enabled.”

Case Study: Tire Manufacturing

When tire manufactures need to release vulcanized (cured) tires from molds, they either use force to remove them or apply a release agent. Pryce Lewis says that tire companies generally don’t use release agents, and the forced removal method can cause tires to deform, affecting performance.

Release agents come in two forms, a spray release agent and a semi-permanent release coating.

The spray release agent is sprayed on the mold and lasts for one to two days, according to Pryce Lewis. The permanent release coating, usually Teflon or an equivalent, is applied using a solvent process and can last weeks or even months.

Chemical vapor deposition can allow greater versatility in the chemistry of the resulting coatings. Image source: GVD Corp.

A process engineer at a U.S. tire manufacturer, who spoke off the record because his company is evaluating GVD coatings, says the commercially available mold lubricant sprays his company used had to be reapplied about every 10 to 12 tires. By contrast, GVD's coatings lasted for months, the source says.

GVD's polymer coatings are 10-25% more expensive than traditional coatings, according to Pryce Lewis.

GVD's RapidRelease product works much the same as the permanent release coatings in terms of durability and method of application, says Pryce Lewis, but offers advantages over the traditional spray-and-bake method, including "excellent adhesion, uniformity and thinness." It does not affect the finish of the tire (glossy/matte) throughout the life of the coating, and it can be applied to both used and new molds with ease, Pryce Lewis says.

RapidRelease is thin and non-stick so it keeps the integrity of fine features and doesn't block mold air vents. The ease of release results in less scrap and higher quality tires. The coatings don't require high-temperature curing, a process "which can deform metal features and puts a lot of stress on the molds," Pryce Lewis says.

Tire molds must be sent to GVD for coating using their application process. This potential disadvantage is not a deal breaker for the process engineer who was interviewed, however, because so far the product performs well and lasts for a long time.

"Permanent coatings and molds haven't taken off because all of the permanent coatings out there – besides this one – would tend to take the textured surface and make it smooth," says the process engineer.

Increasingly complex tire designs could lead to more demand for RapidRelease type polymers. "Treads have a lot more siping, they have serrated siping and they have 3D siping," the process engineer says. In some cases, these designs make it difficult to strip or remove the tire from the mold.

Future Applications

GVD is extending its reach into other industries, including electronics systems. The company collaborated with the Department of Defense to develop an environmental protection coating that can replace hermetic packaging for high-frequency electronics.

Air- and watertight hermetic packages protect a device from the environment. "As you can imagine, they are bulky, heavy and expensive, and impede the drive towards more agile, cost-effective weapons systems," Pryce Lewis says. To meet the requirements set by the Department of Defense, the defense industry is searching for an affordable technology with a smaller form factor, says Pryce Lewis.

Working with its commercial partners, GVD has shown that its technology can be integrated into systems to replace hermetic packaging, Pryce Lewis says. Indications are that it also can provide the same level of protection and performance at a lower cost and with less bulk.

Development of a High-sensitivity Geiger Mode Silicon Photomultiplier

Hye Young Lee, Jin-A Jeon
Space Science Institute, Sungkyunkwan University, Suwon 16419, Korea

Jik Lee, Il H. Park
Department of Physics, Sungkyunkwan University, Suwon 16419, Korea

The silicon photomultiplier (SiPM) is a semiconductor photosensor comprised of many micropixels. Acting as on independent Geiger mode counter that can count a single photon, the micropixels in the SiPM from a highly-sensitive photosensor like a photomultiplier tube (PMT). Also, the SiPM can be applied to various applications that require a fast reaction time, a low power, compactness, etc. If implemented as multi pixels of a SiPM, the photosensor can be used as an image sensor.

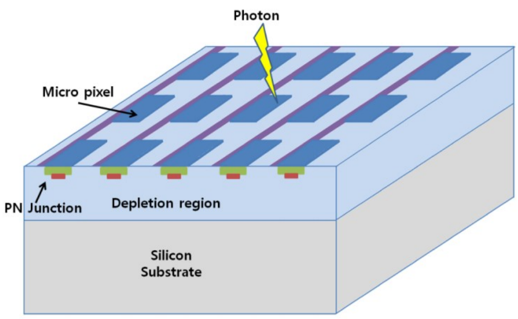


Fig. 1. (Color online) A basic schematic of a SiPM

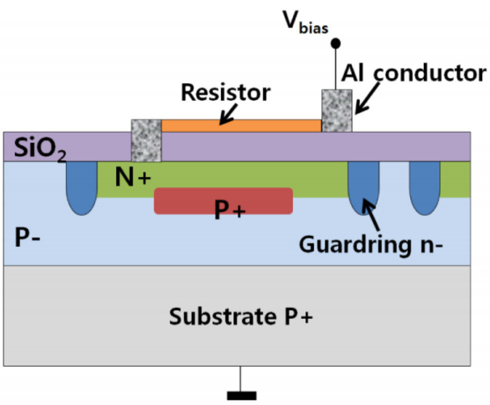


Fig. 2. (Color online) Cross section of a micropixel of the SiPM

Making an array of pixels is useful when a large area has to be covered by the pixels. We have fabricated a high-sensitivity Geiger mode SiPM with 256 micropixels of 35μm×35μm in size for application as a multi-channel SiPM image sensor. The size of the SiPM is 0.5×0.5 mm^2. The device works at 18 V and has the characteristics of single-photon counting, with a gain of 5×10^5, a dark rate of 500 kHz, and photon detection efficient of 33.5% at a 550 nm wavelength.

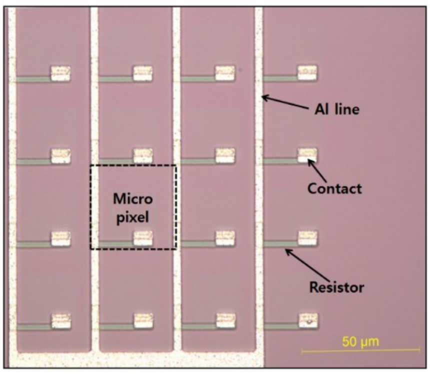


Fig. 3. (Color online) The micropixels of a fabricated SiPM sensor

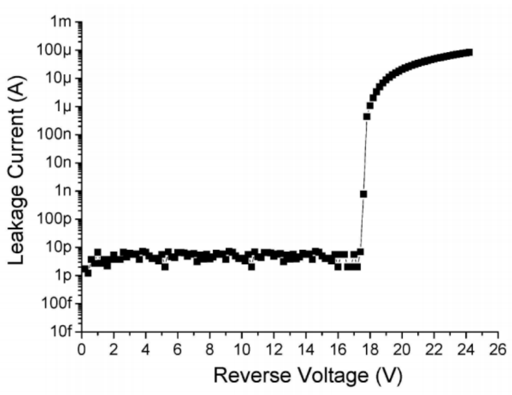


Fig. 4. The I-V curve characteristics of SiPM

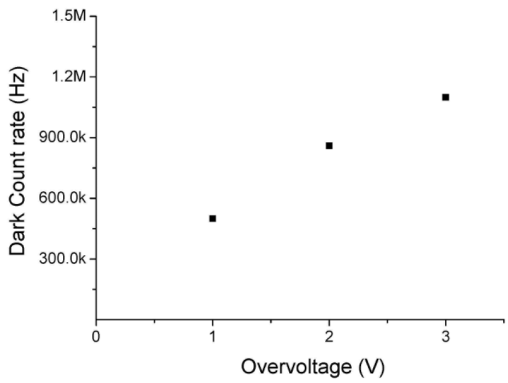


Fig. 5. The SiPM dark count rate for different overvoltages

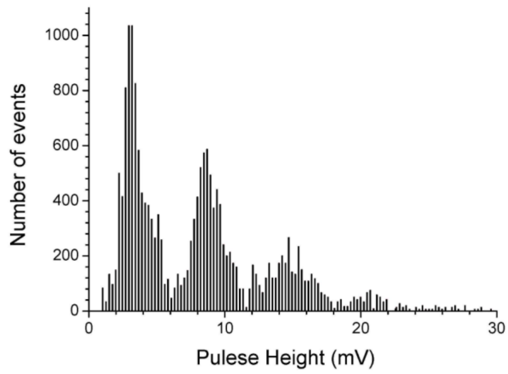


Fig. 7. The SiPM pulse height spectrum with a low light level LED

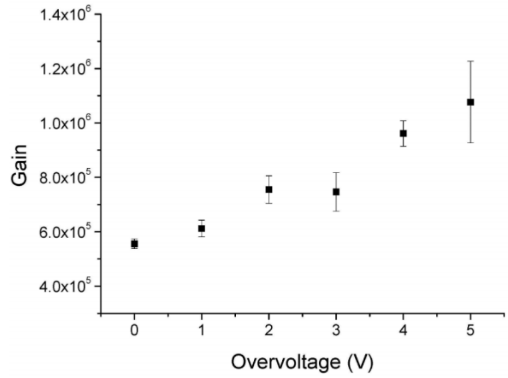


Fig. 6. The SiPM gain as a function of the overvoltages

REFERENCES

[1] C. Piemonte, Nucl. Instrum. Methods A 568, 224 (2006).
[2] N. Dinua, R. Battistonb, M. Boscardinc, G. Collazuold and F. Corsie et al., Nucl. Instrum. Methods A 572, 422 (2007).
[3] H. S. Yoon, G. B. Ko, S. I. Kwon, C. M. Lee and M. Ito et al., J. Nucl. Med. 53, 608 (2012).
[4] http://sales.hamamatsu.com (accessed Nov. 10, 2015).
[5] http://sensl.com (accessed Nov. 10, 2015).
[6] H. Y. Lee, J.-A Jeon, I. H. Park and J. Lee, New Phys.: Sae Mulli 62, 12 (2012).
[7] S. K. Yang, J. Lee, S.-W. Kim, H.-Y. Lee and J.-A Jeon et al., Opt. Express 22, 716 (2014).

From
New Physics: Sae Mulli, Vol. 65, No. 12, December 2015, pp. 1187~1191

Using Nanoparticles to Combat Arteriosclerosis

Sarah Vosen et al.

Vascular Repair by Circumferential Cell Therapy Using Magnetic Nanoparticles and Tailored Magnets, *ACS Nano* (2016)

In industrialized countries, a particularly high number of people suffer from arteriosclerosis—with fatal consequences: Deposits in the arteries lead to strokes and heart attacks. A team of researchers under the leadership of the University of Bonn has now developed a method for guiding replacement cells to diseased vascular segments using nanoparticles. The scientists demonstrated in mice that the fresh cells actually exert their curative effect in these segments. However, much research remains to be done prior to use in humans. The results are now being published in the renowned journal *ACS Nano*.

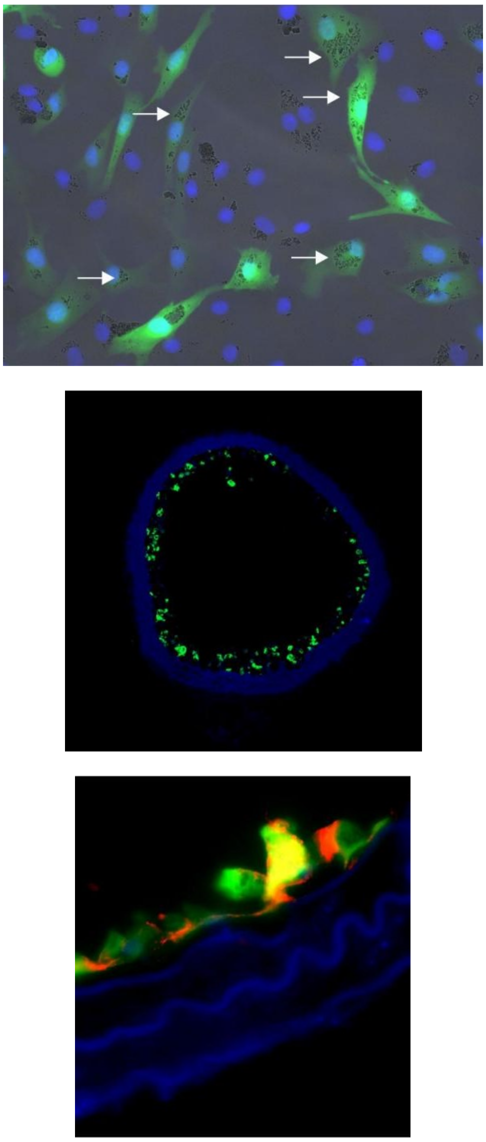
In arterial calcification (arteriosclerosis), pathological deposits form in the arteries and this leads to vascular stenosis. Strokes and heart attacks are a frequent outcome due to the resultant insufficient blood flow. Endothelial cellswhich line the blood vessels play an important role here. "They produce nitric oxide and also regulate the expansion of the vessels and the blood pressure," explains junior professor Dr. med. Daniela Wenzel from the Institute of Physiology I of the University of Bonn. Damage to the endothelial cells is generally the insidious onset of arteriosclerosis.

A team of researchers working with Jun.-Prof. Wenzel, together with the Technische Universität München, the Institute of Pharmacology and Toxicology at the University of Bonn Hospital and the Physikalisch-Technische Bundesanstalt Berlin, developed a method with which damaged endothelial cells can regenerate and which they successfully tested in mice. The scientists transferred the gene for the enzyme eNOS into cultured cells with the aid of viruses. This enzyme stimulates nitic oxide production in the endothelium like a turboloader. "The enzyme is an essential precondition for the full restoration of the original function of the endothelial cells," reports Dr. Sarah Vosen from Jun.-Prof. Wenzel's team.

A magnet delivers the nanoparticles to the desired site

Together with the gene, the scientists also introduced tiny nanoparticles, measuring a few hundred nanometers (one-millionth of a millimeter), with an iron core. "The iron changes the properties of the endothelial cells: They become magnetic," explains Dr. Sarah Rieck from the Institute of Physiology I of the University of Bonn. The nanoparticles ensure that the endothelial cells equipped with the 'turbo' gene can be delivered to the desired site in the blood vessel using a magnet where they exert their curative effect. Researchers at the Technische Universität München have developed a special ring-shaped magnet configuration for this which ensures that the replacement cells equipped with nanoparticles line the blood vessel evenly.

The researchers tested this combination method in mice whose carotid artery endothelial cells were injured. They injected the replacement cells into the artery and were able to position them at the correct site using the magnet. "After half an hour, the endothelial cells adhered so securely to the vascular wall that they could no longer be flushed away by the bloodstream," says Jun.-Prof. Wenzel. The scientists then removed the magnets and tested whether the fresh cells had fully regained their function. As desired, the new endothelial cells produced nitric oxide and thus expanded the vessel, as is usual in the case of healthy arteries. "The mouse woke up from the anesthesia and ate and drank normally," reported the physiologist.



On the left are fluorescence-labeled cells with nanoparticles: The cellular nuclei are shown in blue, the fluorescence labeling is shown in green and the nanoparticles in the cells are identified by arrows. The middle photo shows a blood vessel populated with these cells (green). On the right is a detailed image of a vascular wall with the eNOS protein identified (red). Credit: Dr. Sarah Rieck/Dr. Sarah Vosen/University of Bonn

OPTICS & PHOTONICS NEWS

Making Plasmonic Pixels

Stewart Wills

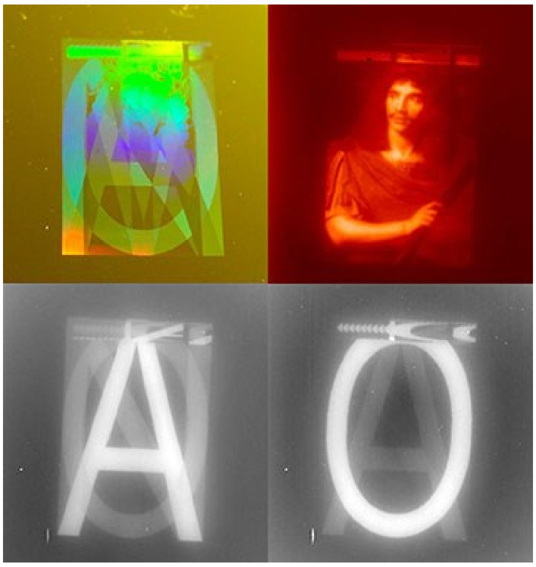
Publish Date: 28 December 2015

A team of scientists in France has created a metasurface on which individual plasmonic nanoantennas act as infrared "pixels," allowing the surface to encode infrared images of surprising detail. The fabrication technique can encode multiple images on a single metasurface that can be read out by using different settings of polarization and wavelength—a characteristic that the researchers believe could make the metasurfaces useful in applications such as anti-counterfeit devices.

Metasurfaces consisting of tiny, resonant metallic antennas at subwavelength length scales have already captured attention for their ability to control and concentrate optical energy at the nanoscale, with potential applications ranging from data storage to spectroscopy. But according to Patrick Bouchon of the French Aerospace Lab, the corresponding author on the new study, most such metasurfaces are based on periodic repetition of the same pattern—sometimes called a "meta-atom"—across the entire surface. That makes the optical properties homogenous across the surface, and potentially limits some applications in imaging and sensing.

To take the next step, the French team set its sights on a nonperiodic surface in which individual nanoantennas could control light both spatially and spectrally. The antennas themselves consisted of 50-nm-thick rectangular gold patches, set atop a 220-nm-thick insulating layer which in turn lay atop a 200-nm-gold layer. In principle, each of these metal-insulator-metal (MIM) patches could be designed to resonate at a different wavelength, acting as a pixel for emitted thermal radiation and allowing for spatial control of the emitted radiation across the surface.

As a proof of principle, the team began by fabricating a surface consisting of six arrays of MIM patches and, using an infrared camera, studying its emission response when heated to a temperature of 373 K. Then, more impressively, they scaled up the process to the order of 100 million antennas on a surface, calculating the array of antennas that would be needed to encode a tiny grayscale reproduction of a painting of the French playwright Moliere. They also added, on the same designed surface, a complementary set of nanoantennas encoding ordinary alphabetic characters, with the nanoantenna design tuned to emit at different polarizations and wavelengths. Under the scheme, each of the antennas on the array would act as an independent subwavelength emitter for a given polarization and wavelength, allowing it to act as a sort of pixel at that position on the metasurface.



The metasurface in visible light (top left) shows no easily decoded information, but emits a picture of the playwright Moliere when heated to 373 K and imaged in the infrared at horizontal polarization (top right), and shows the letters "A" and "O" when imaged at vertical polarization and wavelengths of 4.73 and 5.24 microns, respectively (bottom). [Image: M. Makhsiyan/ONERA]

The team next fashioned the designed metasurface, using software and fabrication techniques developed by the group. While the sample showed no obvious pattern when viewed in visible light (top left in accompanying picture), the image of Moliere emerged when the sample was heated to 373 K (top right) and imaged in a specific wavelength band and polarization. Moreover, in cross polarization, the encoded letters emerged—with each letter visible when filtered at a different wavelength (bottom left and right).

The French scientists believe that the work constitutes an important step forward in the ability to control thermal emission, with relevance to applications such as biochemical sensing, optical storage, and anti-counterfeit devices. Indeed, Bouchon and colleagues are in the process of creating a start-up business to extend the technology into anti-counterfeiting applications.

OPTICS & PHOTONICS NEWS

Thermal Imaging of Single Cells

Sarah Michaud

Publish Date: 05 January 2016

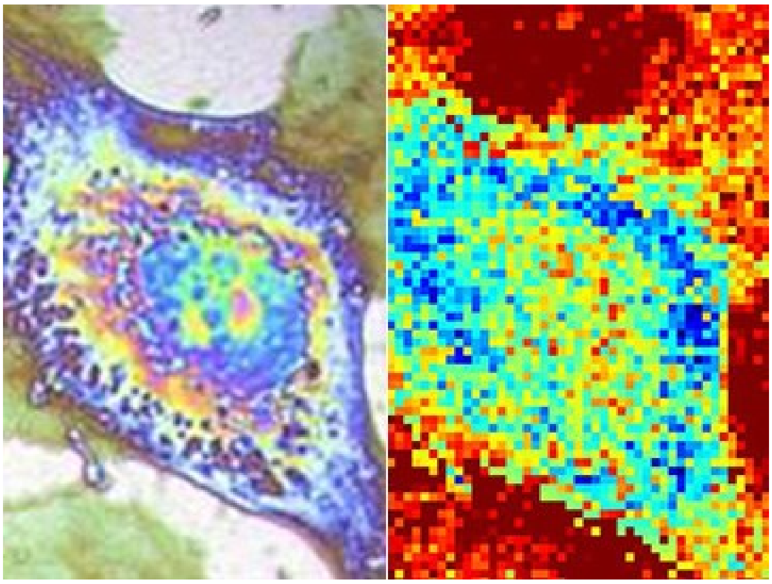
A team of researchers from France reports a new method for thermographically imaging individual cells. The imaging technique uses thermography camera technology—also used in night-vision goggles—and brings it down to the micrometer scale to record thermal activity in cells grown on a thin titanium sheet. The researchers say thermal signatures of cells could be useful in cancer diagnostics and would complement data collected using standard histological methods.

A cell's ability to exchange heat with its environment provides important information about its activity. For example, a cancer cell has a higher metabolism than a normal cell, giving it a stronger thermal signature. A cellular "heat map" could give physicians the ability to not only identify cancer cells, but also determine the effectiveness of anti-cancer therapeutics.

To test their thermal microscopy method, the researchers grew cells on a titanium sheet that served as a thermo-elastic lens. A micrometric spot on the underside of the titanium sheet was then "flash heated" with a Ti-sapphire mode-locked laser. If there wasn't a cell on the other side of the spot, heat from the laser remained in the titanium sheet and caused a slight deformation; if there was a cell on the other side, the cell absorbed the heat from the laser and created a cold spot on the titanium sheet.

The researchers observed that heat absorption varied within the cell—for example, the nucleus absorbed more heat than other intracellular structures. Thermo-elastic deformations in the titanium sheet were picked up by a second laser and translated into a 2-μm-resolution thermal map of the individual cells within the micrometric spot.

Corresponding author Thomas Dehoux, CNRS, says in a press release that these thermal images may "… reveal new information about the behavior of cells because we will be able to observe them with a new contrast." The researchers are working to optimize their thermal imaging technique and would like to someday test the effect of anti-cancer drugs on the thermal properties of cancer cells.



Left: A classical phase contrast microscopy image of a cell. Right: A thermal contrast microscopy image of the same cell. *Credit: Bordeaux University, France*

APS NEWS

Physicists Honored with National Medals

Nation's highest science and technology honors announced

Several prominent physicists are among the newest recipients of the National Medal of Science and the National Medal of Technology and Innovation, announced by the White House on December 22. The awards are the U.S. government's highest scientific and technological honors, and are conferred by the president. In addition to physics, the 17 awardees come from the biological, social, and medical sciences, and from chemistry, engineering, computer science, and mathematics.

Several APS Fellows were recipients of the medals. Physicists awarded the National Medal of Science include Rensselaer Polytechnic Institute President Shirley Ann Jackson, a theoretical physicist who has served prominent roles in U.S. government, including as chairman of the Nuclear Regulatory Commission; Lawrence Berkeley National Laboratory Director Armand Paul Alivisatos, a professor in the departments of materials science and chemistry at Berkeley; and chemical physicist Geraldine Richmond of the University of Oregon, who is the 2015 president of the American Association for the Advancement of Science. All three are APS Fellows. Another APS Fellow, Arthur Gossard of the University of California, Santa Barbara, was awarded the National Medal of Technology and Innovation.
The full lists of awardees are:

National Medal of Science

- Armand Paul Alivisatos, University of California and Lawrence Berkeley National Lab
- Michael Artin, Massachusetts Institute of Technology
- Albert Bandura, Stanford University
- Stanley Falkow, Stanford University School of Medicine
- Shirley Ann Jackson, Rensselaer Polytechnic Institute
- Rakesh K. Jain, Harvard Medical School and Massachusetts General Hospital
- Mary-Claire King, University of Washington
- Simon Levin, Princeton University
- Geraldine Richmond, University of Oregon

National Medal of Technology and Innovation

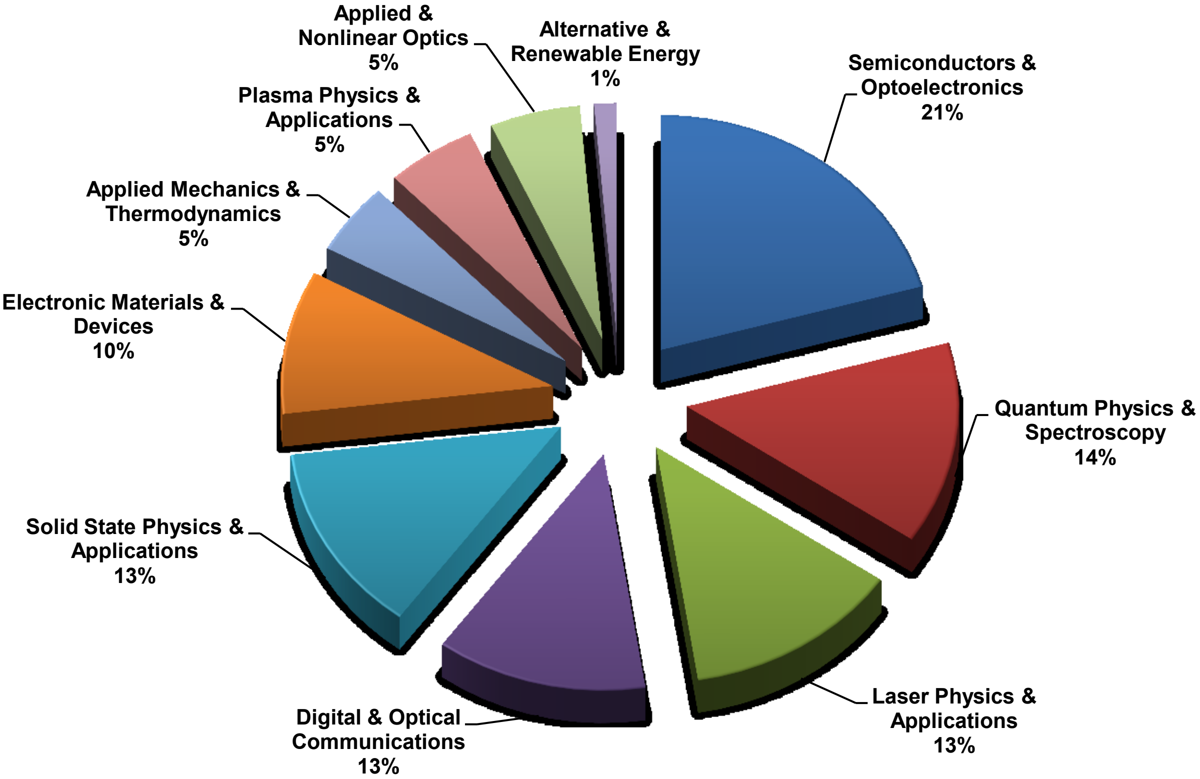
- Joseph DeSimone, University of North Carolina at Chapel Hill, North Carolina State University, and Carbon3D
- Robert Fischell, University of Maryland at College Park
- Arthur Gossard, University of California, Santa Barbara
- Nancy Ho, Green Tech America, Inc. and Purdue University
- Chenming Hu, University of California, Berkeley
- Mark Humayun, University of Southern California
- Cato T. Laurencin, University of Connecticut
- Jonathan Rothberg, 4catalyzer Corporation and Yale School of Medicine

ISSN (printed) 1813-2065, (online) 2309-1673 Printed in IRAQ

Iraqi Journal of Applied Physics

P. O. Box 55259, Baghdad 12001, IRAQ
www.iraqiphysicsjournal.com
Email: info@iraqiphysicsjournal.com
Email: editor_ijap@yahoo.co.uk
Email: irq_appl_phys@yahoo.com

Subject Index 2005-2015



ISSN (printed) 1813-2065, (online) 2309-1673 Printed in IRAQ

Alternative & Renewable Energy
IJAP-AARE

Applied & Nonlinear Optics
IJAP-AANO

Applied Mechanics & Thermodynamics
IJAP-AMAT

Digital & Optical Communications
IJAP-DAOC

Electronic Materials & Devices
IJAP-EMAD

Laser Physics & Applications
IJAP-LPAA

Plasma Physics & Applications
IJAP-PPAA

Quantum Physics & Spectroscopy
IJAP-QPAS

Semiconductors & Optoelectronics
IJAP-SCAOE

 ISSN (printed) 1813-2065, (online) 2309-1673 Printed in IRAQ

Solid State Physics & Applications
IJAP-SSPAA

 ISSN (printed) 1813-2065, (online) 2309-1673 Printed in IRAQ

* * *

Notes:
- 1(1), 3 refer to IJAP, Vol. 1, No. 1, page 3
- L1(1), 3 refer to IJAPLett, Vol. 1, No. 1, page 3

Iraqi Journal of Applied Physics

P. O. Box 55259, Baghdad 12001, IRAQ
www.iraqiphysicsjournal.com
Email: info@iraqiphysicsjournal.com
Email: editor_ijap@yahoo.co.uk
Email: irq_appl_phys@yahoo.com

Author Index 2005-2015

 ISSN (printed) 1813-2065, (online) 2309-1673 Printed in IRAQ

THE IRAQI JOURNAL OF APPLIED PHYSICS
EDITORIAL BOARD

COPYRIGHT RELEASE FORM
IRAQI JOURNAL OF APPLIED PHYSICS (IJAP)

We, the undersigned, the author/authors of the article titled
……
……
……
……
……
that is submitted to the Iraqi Journal of Applied Physics (IJAP) for publication, declare that we have neither taken part or full text from any published work by others, nor presented or published it elsewhere in any other journal. We also declare transferring copyrights and conduct of this article to the Iraqi Journal of Applied Physics (IJAP) after accepting it for publication.

The authors will keep the following rights:
1. Possession of the article such as patent rights.
2. Free of charge use of the article or part of it in any future work by the authors such as books and lecture notes after informing IJAP editorial board.
3. Republishing the article for any personal purposes of the authors after taking journal permission.

To be signed by all authors:

Signature:…………………………………………………………………..date: …………………………………………
Printed name: ………

Signature:…………………………………………………………………..date: …………………………………………
Printed name: ………

Signature:…………………………………………………………………..date: …………………………………………
Printed name: ………

Correspondence address:……………………………………………………………………………………………..
……
Address:……
……
Telephone:…………………………………………..email: ……………………………………………………………...

Note: Complete and sign this form and mail it to the below address with your finally revised manuscript

The Iraqi Journal of Applied Physics
P. O. Box 55259, Baghdad 12001, IRAQ
www.iraqiphysicsjournal.com
Email: info@iraqiphysicsjournal.com
Email: editor_ijap@yahoo.co.uk
Email: irq_appl_phys@yahoo.com
Email: editor@ijaponline.com