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Photonics CENTER

INTERNATIONAL YEAR OF LIGHT 2015

PARC

Photonics Advanced Research Center

NEWS LETTER

文部科学省 先端融合領域イノベーション創出拠点形成プログラム

大阪大学フォトニクス先端融合研究拠点

Vol. 4

国際『光』年、『光』はいま、阪大から世界へ。

The International Year of Light – Light from Osaka Illuminates the Way

対談 *Special Talk*

満を持して世界に大きく花開く「フォトニクス / 光の科学と応用」

Blossoming at long last

Photonics: The science and application of light

平野 俊夫 × 河田 聡

大阪大学総長
Toshio HIRANO
President, Osaka University

フォトニクスセンター長
Satoshi KAWATA
The Executive Director of PARC

特集 *Feature*

ノーベル賞研究をさらに発展させる大阪大学の研究者たち
Osaka University Researchers Advance Nobel Prize-Winning Technologies

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フォトニクス研究を国際的に展開するには
Photonics Center promotes internationalization of Osaka University to become a world center for photonics innovation

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  The International Year of Light and Light-based Technologies 2015
- 大阪大学・モロッコフォトニクス国際共同研究の推進
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「フォトニクス / 光の科学と応用」

Blossoming at long last
Photonics: The science and application of light

**大阪大学フォトニクス先端融合研究センターには、
「光の科学と応用」をリードする著名な研究者が分野を超えて集まり、
多様なイノベーションを生み出しています。
注目を集める「フォトニクス」の現状や今後について、
平野俊夫総長と河田聡センター長が語り合いました。**

The Photonics Center at Osaka University brings together prominent researchers
who are playing a leading role in the science and application of light to spur a variety of innovations.
Osaka University president Toshio Hirano and
Photonics Center executive director Satoshi Kawata
spoke about the current status and future prospects of the photonics,
which has been attracting significant interests recently.

21世紀は「光の世紀」フォトニクスで新しい時代を創る

平野―― 2014年のノーベル賞は、青色発光ダイオード（LED）の開発と実用化に貢献した3人の日本人科学者が物理学賞を、超解像の蛍光顕微鏡を開発した欧米の3人の研究者が化学賞を受賞し、光に関する研究が高く評価されました。また2015年は国連が宣言した「国際光年（International Year of Light）」。今後、フォトニクスの重要度は、さらに増していきそうですね。

河田―― 2015年はフレネルが「光の波動説」を唱えて200年。マクスウェルが光に電磁波の概念を持ち込んで150年になります。また最近でもここ数年で光に関する研究で多くのノーベル賞受賞者が出るなど、まさに「光の」年を迎えつつあると感じます。

平野―― まさにフォトン（Photon/光の粒子）の時代、そしてフォトニクスセンターの時代ですね。

河田―― エレクトロニクスが「電子（エレクトロン）」を扱うのに対し、フォトニクスは「光子（フォトン）」が研究対象です。フォトニクス研究では光を利用して、物質や情報の処理や機器の制御が行われています。トーマス・エジソンの時代から約130年間、エレクトロニクスが社会を支えてきましたが。こ

大阪大学総長
平野 俊夫
Toshio HIRANO *President, Osaka University*

Special Talk 対談

フォトニクスセンター長
河田 聡
Satoshi KAWATA *The Executive Director of PARC*

21st century as the century of light: Creating a new era through photonics

President HIRANO —— Three Japanese scientists received the 2014 Nobel Prize in Physics for their contributions to the development and commercialization of blue LEDs, while three European and American researchers received the 2014 Nobel Prize in Chemistry for their development of super-resolution fluorescence microscopy. Both of these prizes recognized research into light. In addition, the United Nations has declared 2015 the International Year of Light. Going forward, the field of photonics seems poised to become an increasingly important one.

Executive Director KAWATA —— The year 2015 marks the passage of 200 years since Fresnel proposed the wave theory of light, and 150 years since Maxwell incorporated the concept of electromagnetic radiation into our understanding of light. With numerous scientists who are conducting research into light having received Nobel Prizes in the past several years, you can see how it really is the Year of Light.

HIRANO —— We have truly embarked on the era of the photon and of the Photonics Center.

KAWATA —— Whereas electronics deals with the electron, photonics deals with the photon. In photonics research, light is used to probing materials, processing information, and controlling devices. During the 130 or so years since Thomas Edison's time, electronics has played a key role by underpinning the development of society. In the future, it seems fair to say that photons traveling through free space will take the place of electrons traveling through wires. An age in which communications and control are made by using photons from inside the human body to throughout space is about to dawn. We're seeing tremendous progress in terms of both the technology and the science.

れからは電線の中を走るエレクトロンに代わり自由空間を伝わるフォトンが使われることでしょう。生体の内部も宇宙空間もフォトンで通信し制御をする時代が来ます。技術的にはもちろん科学的にも大いに進歩があります。

超学際的な発想とシステムで「イノベーション」を生み出す

平野—— 大阪大学にはフォトニクスセンターに限らず複数の光関連の研究センターがあり、また多くの部局で基礎から応用にいたる研究が行われています。フォトニクスに関する研究が活発で、論文の数も非常に多い。日本のトップランナーであることはもちろん、世界的なフォトニクスの拠点として多くの研究成果を発信してきました。このような背景のもと、大阪大学におけるフォトニクス研究のポテンシャルを一層高め、部局横断的な研究を推進するため、未来戦略機構の第八部門として「光量子科学研究部門」を創設しました。これは部局の壁を乗り越えて研究者をバーチャルに集める組織です。異分野融合領域などにおける新しいインタラクション（相互作用）により研究が進むことを期待しています。河田先生率いるフォトニクスセンターでも、ぜひノーベル賞を受賞していただきたいですね（笑）。また私が専門とする免疫学においても、高い空間分解能を有する光学顕微鏡などにより、生体内の分子レベルまで鮮明に見ることができ、新しい発見に結びつくという期待を持っています。これなどはフォトニクスの応用分野になりますね。

河田—— 光は、いろいろな分野に貢献していて、国際光年に関してユネスコも「光は科学・技術・芸術・文化の中心にある」と言っています。実は、このフォトニクスセンターの建物全体がLEDの実験棟となっていて、全館にLED照明を備えています。各部屋のLED照明はセンサーネットワークによって人の存在と自然光を感じ、色と照度をコントロールしています。人が色と照度をどのように理解し、人の感性にどう影響するか。人と照明環境の関係を探ることも研究テーマとなっています。

平野—— 光のスペクトルを調整することで、人の心理操作も可能なわけですね。

河田—— 人類に貢献できる光の研究も、縦割りの組織で個別にやっていてはなかなか新しい発見や発明は生まれません。フォトニクスセンターでは国際光年の目指すものと同様に「トランスディシプリナリティ（超学際）」の考えで、物理・化学・生物などの分野や部局を超えた切り口の研究を実施していきたいと思います。

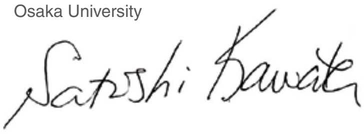
総長 対談 河田

Creating innovation with trans-disciplinary approaches and systems

HIRANO —— Osaka University is home to not only the Photonics Center, but some light-related research centers, and many departments are carrying out research in the field, ranging from fundamental researches to applications. An enormous amount of research is being conducted in the area of photonics, and an extremely large number of papers are published. The University has disseminated numerous research findings as one of Japan's premier leaders in the field, and as an international center of photonics research. Against this backdrop, we created the Division of Photon Science and Technology as the eighth division of the Institute for Academic Initiatives in order to boost the potential of photonics education and research at the University while promoting research that cuts across departmental boundaries. The Division is an organization that brings together researchers from different departments virtually in order to foster research through new interactions, for example in domains that combine different fields. I'd love to see your Photonics Center receive a Nobel Prize, too! Looking at my own specialty of immunology, innovations such as optical microscopes with super-resolution have made it possible to observe structures in the body right down to the protein level with a high degree of clarity, and we expect these technologies to lead to new discoveries. I suspect that many other fields will see the same sort of progress by applying photonics.

KAWATA —— Light contributes to a variety of fields, and even UNESCO has noted that light "lies at the center of science, technology, art, and culture" in its comments on the International Year of Light. In fact, the Photonics Center building itself is a gigantic LED experiment since the entire building has been equipped with LED lighting. The color and illuminance of the LED lighting in each room is controlled by a network of sensors that detects whether the room is occupied and how much natural light is entering it. In asking how people understand color and illuminance and how those factors affect people's sensibility, we have taken the relationship between people and the lighting environment as a subject of research.

フォトニクス先端融合研究センター長
特別教授
河田 聡
Satoshi KAWATA
The Executive Director of PARC
Distinguished Professor
Graduate School of Engineering
Osaka University



平野――　今おっしゃった「トランスディシプリナリティ」のような多様性こそが、イノベーションの源泉となります。分野の異なる人がインタラクションすることで、従来とは全く異なる発想が生まれ、革新的なイノベーションを起こすことができます。そういう意味でフォトニクスセンターは、大阪大学が目指している「世界適塾」の理念にピッタリだと思います。大阪大学は2031年に創立100周年を迎えますが、「原点である適塾から世界適塾へ」という世界適塾構想のもと、世界トップテンの研究型総合大学を目指しています。民族・言語・文化・宗教などの多様性は人類を発展させてきた一方で、壁を作り、戦争や紛争などを生じさせます。しかし学問は芸術やスポーツと同じ人類の共通言語であり、学問によって調和ある多様性を実現していくことができます。河田先生は、まさに多様な学問の壁を乗り越えた新しい調和（研究分野・切り口）を生み出そうとしておられると感じます。

河田――　ぜひ、そうありたいと思います。哲学から自然科学が分離されて300年。物理・数学・化学が分かれて百数十年。学問の縦割りの歴史はそんなに長いわけではありません。いつの間にか高くなってしまった学問間の壁を壊し、ブレークスルーしたいと思います。フォトニクスセンターには実に多様な分野の研究者が集まっていますし、フォトニクスをビジネスチャンスと捉える企業人も参加しておられます。

国立大学法人 大阪大学 総長
平野 俊夫
Toshio HIRANO
President
Osaka University

新しいものを創造するカルチャーに世界の光研究者が集まってくる

平野――　世界適塾や未来戦略機構のコンセプトを先取りしておられますね。またトランスディシプリナリティとは科学と現実社会が交わる領域のことで、つまり、フォトニクスも実は一般の人にとっても身近な話だということですね。

河田――　フォトンには質量はありませんが「運動量」を持っています。ですから光が当たれば、モノは押されて動きます。

HIRANO ―― So by adjusting the spectrum of light, it's possible to influence people's psychological state for human friendly circumstances.

KAWATA ―― Research projects into light, that promise to contribute to humankind, fail to yield new discoveries and inventions when carried out separately by horizontally divided organizations. At the Photonics Center, our goal—like the goal of the International Year of Light—is to carry out research from perspectives that transcend fields and departments such as physics, chemistry, and biology based on the approach of trans-disciplinarity.

HIRANO ―― Diversity, like the concept of trans-disciplinarity that you just mentioned, is the font of innovation. Interactions among people from different fields yield quite different ideas and innovations. In that sense, the Photonics Center is ideally suited to the University's concept of the global university "World Tekijuku." The University will celebrate the 100th anniversary of its founding in 2031, and we are striving to become one of the top 10 research universities in the world in keeping with the concept of "developing from the Tekijuku into the World Tekijuku." Even as they have spurred human societies, diversities in language, culture and religion have led to the creation of walls and fueled war and other conflicts. However, science is like a common human language just as are art and sports, and it is possible to realize harmonious diversity through science. It seems to me that what you are doing is precisely to create a new type of harmony (in terms of research fields and perspectives) that transcends the walls of various disciplines of science.

KAWATA ―― Yes, that is my goal. It has been 300 years since the natural sciences separated from philosophy and several decades since physics, mathematics, and chemistry became separate disciplines. My point is that the vertical walls we find between learning disciplines are not so old as you might think. I would like to pursue new breakthroughs by breaking down those walls, which somehow grew in height before we realized what was happening. Researchers from a truly diverse range of fields have gathered at the Photonics Center, and there are even companies that see photonics as a business opportunity participating in our efforts.

Photonics researchers from around the world gather, drawn by a new culture for leading forefront.

HIRANO ―― You are going ahead of what is intended to realize by the global university and the Institute for Academic Initiatives. I think transdisciplinarity is the domain in which science and contemporary society intersect, which means that photonics is actually a familiar subject for the general public.

KAWATA ―― Even though a photon do not have mass, it has momentum. Consequently, matter is pushed and moves when shined by light. A comet's tail is formed when gas experiences pressure from light from the sun, pushing it in the opposite

彗星の尾は太陽の光の圧力を受けてガスが太陽と反対側に押されてできています。運動量保存の法則に従っています。光の放射圧で宇宙を飛ぶ「光子ロケット」は80年前にドイツの航空宇宙技術者であるオイゲン・ゼンガーが提案しました。それを漫画にしたのがテレビアニメの「マジンガー Z」です。携帯電話による通信も、電波領域の光の技術です。最近では、建物などの立体に映像を映し出す「プロジェクションマッピング」など、アート表現にも光技術が活躍し、人々を楽しませています。私は2008年に、文部科学省からの委託で「一家に1枚、光マップ」というポスターを作成しました。光が自然界や私たちの生活の中でどのように使われているかを一覧できる光の地図です。国立科学博物館（東京都）などで販売されていますが、光に関する研究に対するノーベル賞などが相次ぐなどその進歩が激しいので、現在、内容を改訂しているところです。1980～1990年頃から特に基礎的な科学技術の種が育ち、満を持して様々応用へ大きく花開きつつあるのがフォトニクスの現状だと思います。

平野——　2014年3月、未来戦略機構のシンポジウムとして「Opt Osaka 2014 in Tokyo－大阪大学の光科学100－」を開催しました。光量子科学に関わる100を超える研究室やグループがポスターセッションを行うなど壮観でした。今日も光研究の素晴らしい可能性を聞かせていただき、興味深かったです。センターの総括責任者として、また未来戦略機構を通じて今後もフォトニクスセンターの活動を推進していきたいと思います。

河田——　2015年1月14に、大阪で未来戦略機構国際シンポジウム「Opto Osaka 2015」を開催しました。今回は世界の著名人をお呼びし世界的視点からフォトニクスの最先端と未来を議論しました。大阪大学は懐徳堂や適塾の頃から新しいことに取り組むことが得意であり､私たちの使命だとも感じています。世界の光の研究者が分野を超えてフォトニクスセンターに来てくれているのも、そのようなカルチャーがあるからだと思います。また今日は平野総長からも、フォトニクス研究の意義について共鳴していただき、大変心強く感じました。ありがとうございました。

平野　対談　河田

direction. In this behavior, the principle of the conservation of momentum is upheld. The “photon rocket,” whose propulsive force derives from the radiation pressure of light, was proposed by a German aerospace engineer, Eugen Sanger 80 years ago. The manga television series *Mazinger Z* was based on this concept. When we communicate using mobile phones, we are using technology that exploits light in the radio wave region. Recently, light technology has been used to give people pleasure through art, for example in projection mapping, which projects images onto three-dimensional surfaces such as buildings. In 2008, I designed a poster entitled “Light Map for Every Home” at the request of the Ministry of Education, Culture, Sports, Science and Technology. This Light Map illustrates how light is used in the natural world and in our own lives. The poster is available for purchase at places such as the National Museum of Nature and Science in Tokyo, but I’m currently revising the design in light of recent rapid progress in light-related research, which is highlighted by a series of Nobel Prize awards and other developments. Today, the field of photonics is finally blossoming into a myriad of applications thanks to seeds that were sewn from 1980 to 1990 in the form of basic technologies.

HIRANO —— In March, 2014, we held an Institute for Academic Initiatives symposium entitled “Opt Osaka 2014 in Tokyo: 100 Years of Light Science at Osaka University.” It was quite a success, with over 100 labs and groups participating in the poster session. Today, I very much enjoyed discussion with you on fantastic potential of light and light based technologies. I, as the program chair of the Photonics Advanced Research Center, Formation of Innovation Center for Fusion of Advanced Technologies, and also through the activities of the Institute for Academic Initiatives, would like to encourage and support for Photonics Center to pursue and realize its mission.

KAWATA —— We held Opto Osaka 2015 as an international symposium of the Institute for Academic Initiatives on January 14, 2015. This time, we invited prominent scientists in the field from UK and USA to discuss the state of the art and the future of photonics from an international standpoint. Osaka University has been very good at getting involved with new research fields since the time of the Kaitokudo and Tekijuku, and I feel that this is our very important mission. I think it’s this unique culture that attracts photonics researchers from around the world and from various fields to come to the Photonics Center. I’m grateful to have heard you express similar views about the significance of photonics research today. Thank you.

デバイス特性を飛躍的に向上させる高品質 GaN ウエハ

Dramatically Improved Device Properties through High-Quality GaN Wafers

大阪大学大学院工学研究科
電気電子情報工学専攻
教授
森　勇介
Yusuke MORI
Professor
Division of Electrical, Electronic and Information Engineering
Graduate School of Engineering
Osaka University

2014年度のノーベル物理学賞はGaN系窒化物半導体を基盤材料に開発された青色LEDに贈られました。天野先生と14年程研究をご一緒させていただいている研究者の一人として心よりお祝い申し上げます。

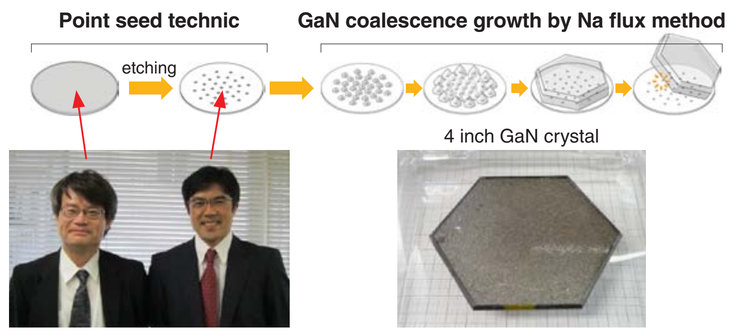
GaN系窒化物半導体は、半導体材料の中では理論的には最も優れた光・電子特性を有しているものの、品質の良い結晶が全く出来ず、デバイス作製なんて夢のまた夢という状況でした。そのような状況で、赤碕先生、天野先生は低温バッファー層という画期的な結晶育成技術を開発し、さらには従来不可能と思われていた電気伝導性制御をも実現されました。その結果、青色LEDの実用化が達成され、今回のノーベル物理学賞受賞の栄誉に浴されました。

一方で、低温バッファー層技術では、サファイア等の異種基板を用いているため結晶の品質向上には限界があり、GaN系窒化物半導体の潜在能力を100%出し切るには、シリコンやGaAsのようなバルク結晶育成技術の開発が不可欠になります。

私は波長変換結晶$CsLiB_6O_{10}$の光材料の研究開発をしていましたので、学会等で天野先生とお話する機会があり、その時に、天野先生から、これからはバルクGaN結晶が必要だというお話を聞いていました。また、1996年に米国で開催されましたMRSで偶々ご一緒になった時に、これから面白い発表がありますよ、と東北大学の山根先生のNaフラックス法の講演を拝聴したのが、バルクGaN結晶の研究を始めたキッカケです。

５年間、大きなGaN結晶は出来ませんでしたが、2001年８月に京都で開催されましたICCG-13において、天野先生に先生のGaN薄膜結晶を阪大の種結晶として使わせて欲しいとお願いし、ご快諾頂いたことで、研究が一気に加速しました。天野先生の方法で作製したGaN薄膜は転位が$10^9/cm^2$程含まれているのですが、その種結晶上にNaフラックス法で育成すると転位密度が$10^5/cm^2$程度まで急激に減少することを発見したのです。その後10年程で、サファイア基板上のGaN薄膜結晶からポイントシードを作製するという新展開で、大口径化とさらなる高品質化を両立できる全く新しいGaN結晶育成技術の研究開発に成功いたしました。

今後は、本研究成果を基に、デバイス特性を飛躍的に向上させる高品質GaNウエハを実用化すべく研究開発を推進して参ります。



Combination of two innovations created by Prof. Amano & Osaka Univ.
Schematic illustration of point seed technic for GaN crystal coalescence growth.
Point seed is made from the GaN substrate obtained by Prof. Amano's innovation.
High quality large diameter GaN crystal can be grown by Na flux method by using point seed.

The 2014 Nobel Prize in Physics was awarded jointly to three Japanese researchers for developing blue light-emitting diodes (LEDs) using GaN-based semiconductors. I have had the pleasure of working for about fourteen years on research with one of those researchers, Dr. Hiroshi Amano, to whom I extend my heartfelt congratulations.

While GaN-based semiconductors theoretically have the best optical and electronic properties of all semiconductor materials, manufacturing any devices with these semiconductors was previously nothing but a fantastic notion since it was believed that high-quality GaN crystals could not possibly be grown. However, Dr. Isamu Akasaki and Dr. Amano developed a revolutionary technique of growing low-temperature deposited buffer layers and further succeeded in achieving conductivity control, which at that time was thought impossible. This led to the development of efficient blue LEDs for which they were recognized with the Nobel Prize in Physics.

However, there is a limit to how much low-temperature deposited buffer layer technology can improve the quality of crystals grown on heterogeneous substrates such as sapphire. In order to realize the full potential of GaN-based semiconductors, it will be essential to develop a bulk crystal growth technology such as that used for silicon and GaAs.

I have had several opportunities to speak with Dr. Amano at academic conferences and the like as I was conducting R&D on optical materials employing $CsLiB_6O_{10}$ wavelength conversion crystals. On one such occasion, Dr. Amano predicted a coming need for bulk GaN crystals. Then by chance, I ran into him at the 1996 Materials Research Society held in the U.S., and he told me that there was a presentation coming up I might be interested in. He was talking about a lecture by Dr. Hisanori Yamane of Tohoku University on the Na-flux method, which became the impetus for me to begin research on bulk GaN crystals.

For five years, I was unable to grow any large GaN crystals. However, in October 2001 at the Thirteenth International Conference on Crystal Growth held in Kyoto, I again met Dr. Amano and asked him if I could use his GaN film crystal as a seed crystal at Osaka University. He consented immediately, and our research instantly took off. While the GaN thin films produced according to Dr. Amano's method include a dislocation density of approximately $10^9/cm^2$, we discovered that using the Na-flux method to grow crystal from this seed crystal radically reduced the dislocation density to about $10^5/cm^2$. About ten years later, owing to the new development of point seeds produced from GaN film crystals on a sapphire substrate, we succeeded in developing an entirely new technique for growing GaN crystals that achieves both a large diameter and improved quality.

I hope to build on this accomplishment with continued R&D on the production of a practical high-quality GaN wafer capable of dramatically improving device properties.

超解像光学顕微鏡の開発

The Development of Super-Resolved Fluorescence Microscopy

大阪大学大学院工学研究科
精密科学・応用物理学専攻
准教授
藤田 克昌
Katsumasa FUJITA
Associate Professor
Department of Applied Physics
Graduate School of Engineering
Osaka University

2014年のノーベル化学賞には「超解像光学顕微鏡の開発」が選ばれました。光学顕微鏡とは光を試料に当てて観察する顕微鏡で、材料工学から医学まで広い分野の研究に利用されています。光学顕微鏡の解像力は光の波としての性質により制限されている、とドイツのAbbeが1870年代に示してから、多くの研究者がその限界を超えることに挑戦してきましたが、Eric Betzig、Stefan Hell、William E. Moernerの3氏の功績が特に評価され、受賞されました。

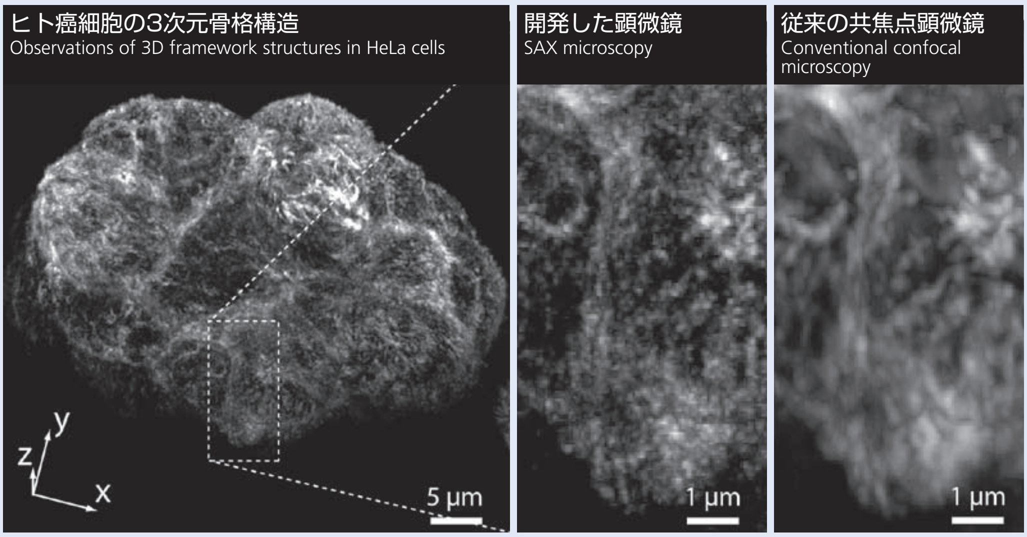
超解像光学顕微鏡の開発というのは、私が博士前期課程（修士課程）の研究として与えられたテーマです。1995年に、当時ご指導いただいていた河田聡先生、故 中村收先生から超解像顕微鏡の研究のテーマをいただき、それが現在まで続くライフワークとなっています。その頃、Hell氏、Betzig氏は、今回の受賞のもとになった超解像顕微鏡の理論を発表しており、その内容について河田先生、中村先生と頻繁に議論していました。顕微鏡関係の国際会議でHell氏とも知り合いになり、博士後期課程の在学中に彼の研究室に短期留学する機会を得ることができました。中村先生はHell氏と共著の解説論文も執筆されています[1]。

私自身は博士号取得後、バイオ関係の研究に興味を持ち、超解像顕微鏡の研究から離れていた（Hell氏からのポスドクのオファーを断ってしまいました）のですが、興味は尽きず、常にオリジナルな超解像法を考え続けていました。アイデアが浮かんだのは2004年で、ヒントは、その頃から担当を始めた「計測制御工学」の授業にありました。当時、阪大病院に入院されていた中村先生にお話したところ、是非進めるようとの言葉をいただきました。新しい研究を進めるのは結構勇気が必要なことなのですが、すぐさま特許出願を行い、開発を始めました。

私のアイデアは、蛍光発光の飽和を利用するというものです（飽和励起顕微鏡）[2]。試料に照射する光の強度と、それによって生じる蛍光の強度（これを測定して観察画像をつくります）は通常は比例関係になるとされていますが、照射する光の強度を大きくすると、発光の強度が飽和してしまいます。この飽和はレーザーの集光点の内部の光の特に強い部分だけ起こるので、この飽和した蛍光を検出しながらレーザー集光点を走査すれば、高い解像力で観察することができます。図はこの方法で観察したヒト癌細胞の3次元観察像です[3]。従来の手法に比べ試料内部の構造がより詳細に観察されていることが分かります。研究開始当初は研究予算の獲得に何度も失敗しましたが、少しずつ装置を開発していき、3年ほど掛けて装置を完成させました。

今年で、飽和励起顕微鏡の開発をスタートしてから、また中村先生が亡くなってから10年になります。超解像顕微鏡自体は実用化されて間もなく、応用面での利点、欠点についてはまだ十分には理解されていません。ノーベル賞が贈られたとは言え、まだまだ課題は多くあります。後々まで、また多くの人に使っていただける超解像顕微鏡の実現を目指し、これからも研究を続けていきたいと思います。

[1] 中村 收, ステファンヘル, 計測と制御, 36, 330 (1997).
Osamu Nakamura and Stefan W. Hell, *Journal of the Society of Instrument and Control Engineers*, 36, 330 (1997).
[2] K. Fujita, et al., *Phys.* Rev. *Lett.*, 99, 228105 (2007).
[3] M. Yamanaka, et al., *J. Biomed. Opt.*, 18, 126002 (2013).



ヒト癌細胞骨格構造の観察結果
3D framework structures in HeLa cells

Osaka University researchers

"The development of super-resolved fluorescence microscopy" was chosen for the 2014 Nobel Prize in Chemistry. Optical microscopy employs light to observe specimens and is used in a wide range of research fields, from materials science and engineering to medical science. Ever since the German physicist Ernst Abbe declared in the 1870s that the resolution of optical microscopes was limited by the wavelength of the source light, many researchers have attempted to exceed this limit. The three researchers Eric Betzig, Stefan W. Hell, and William E. Moerner, who received the 2014 Nobel Prize, were recognized as being particularly successful in their attempts.

The development of super-resolved fluorescence microscopy was the research topic given to me in my predoctoral program (master's program). Prof. Satoshi Kawata and the late Prof. Osamu Nakamura, who were my mentors at that time, gave me the research theme "super-resolution microscopy" in 1995, which I have adopted as my lifework and have carried on ever since. Around that time, Dr. Hell and Dr. Betzig had presented a theory on super-resolution microscopy that became the basis for their award-winning work, the content of which I discussed frequently with Dr. Kawata and Dr. Nakamura. I became acquainted with Dr. Hell at international conferences on microscopy and had the opportunity to work briefly at his lab as an exchange student. Prof. Nakamura also coauthored a paper with Dr. Hell for publication.[1]

After completing my PhD study, I became interested in biotechnology-related research and temporarily distanced myself from super-resolution microscopy (even turning down an offer for postdoc work from Dr. Hell). However, my interest in microscopy never waned, and I was always contemplating original ideas for super-resolution techniques. An idea came to me in 2004 during a course that I had recently been placed in charge of on Instrumentation and Control Engineering. I spoke with Prof. Nakamura who had been admitted to Osaka Hospital at that time, and he urged me to pursue this research. While it takes considerable courage to initiate a new research topic, I immediately decided to file a patent application for my idea and get started on development.

My idea was to employ the saturation of fluorescence emissions in microscopy (saturated excitation (SAX) microscopy).[2] While it was commonly assumed that the intensity of light irradiated on a specimen was proportional to the intensity of fluorescence emitted in response (the values are measured to create an image), the initial fluorescence intensity becomes saturated when excitation intensity becomes sufficiently high. This saturation is localized in the most intense region of the laser focus. Hence, it is possible to observe the specimen at high resolution by detecting the saturated fluorescent light scanning the laser focus while scanning the laser focus detecting the saturated fluorescent light. The figures show 3D images of human cancer cells (HeLa cells) observed through this technique.[3] From these images, it is clear that the internal structure of the specimen can be observed in more detail than when using conventional confocal techniques. At the beginning of this study, we many times failed to acquire the necessary research budget, but little by little we developed more equipment and, after three years, have completed our work.

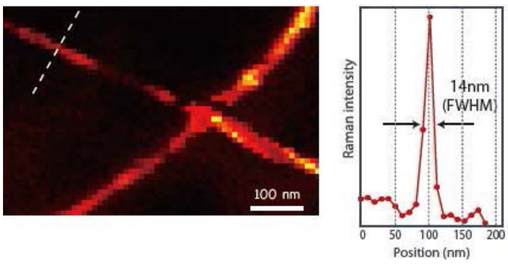
This year marks ten years since I began developing the SAX microscope and also since the passing of Prof. Nakamura. It is too soon since the realization of super-resolution microscopy to fully understand its advantages and disadvantages from an application perspective. Despite the technique receiving recognition with the Nobel Prize, many challenges remain. I intend to continue my research with the goal of achieving super-resolution microscopy techniques that will be used by many people for a long time to come.

超解像先端増強ラマン顕微鏡の商品化

Productization of
Tip-Enhanced Raman Scattering Microscope

超解像光学顕微鏡には、ノーベル化学賞で受賞したものや藤田准教授等の開発している遠視野顕微鏡far-field microscopyの他、近接場顕微鏡がある。大阪大学フォトニクスセンターは、河田聡教授が発明した「先端増強ラマン散乱顕微鏡」の製品化研究を2012年—2013年度に支援し、その研究成果をナノフォトン株式会社に技術移転し、2013年に同社から「TERSsense」という名称で製品発表しました。同顕微鏡は、観察試料上を先鋭な金属ナノ探針（プローブ）で走査することによって、金属ナノ探針の先端に生じる表面プラズモンを光ナノスポットとして活用し10ナノメーターの空間分解能があります。

The super-resolution optical microscopes, which have been awarded Nobel Prize in Chemistry in 2014 and Prof. Fujita is developing are far-field microscopes. Another kind of super-resolution microscope, a near-field microscope has been invented and productized by Prof. Kawata, Photonics Center, Osaka University. The microscope is tip-enhanced Raman scattering microscope and the product is named "TERSsense" capable of 10 nm spatial resolution.



Carbon nanotube G-band image (left) and intensity profile showing 14 nm spatial resolution (right).

窒化物半導体 赤色発光ダイオードの開発

Development of Red Light-Emitting Diodes Using Nitride Semiconductors

大阪大学大学院工学研究科
マテリアル生産科学専攻
教授
藤原 康文
Yasufumi FUJIWARA
Professor
Division of Materials and Manufacturing Science
Graduate School of Engineering
Osaka University

発光ダイオード（LED）はディスプレイや照明等、地球規模の「省エネ」や「CO_2削減」など環境対策に貢献する「エコデバイス」として脚光を浴びています。2014年ノーベル物理学賞の対象となった、窒化物半導体を用いた青色LEDや緑色LED（ともに$In_xGa_{1-x}N/GaN$系）の画期的な発明により、従来の赤色LED（$In_xGa_yAl_{1-x-y}P/GaAs$系）と組み合わせた大画面フルカラーLEDディスプレイが開発され、屋外の至る所で見掛けられるのが現状です。一方、青色LEDと黄色蛍光体を組み合わせた白色LEDは超小型、超軽量、長寿命、容易駆動といった特徴を最大限に活かして、カラー液晶ディスプレイのバックライトに用いられています。また、最近では、白色LEDの高輝度化・高効率化に伴い、従来の白色電球や蛍光灯からLED照明への置き換えが急速に進展しています。

このような背景の中、窒化物半導体を用いた赤色LEDの開発が強く求められています。既に実用化されている青色LEDや緑色LEDでは発光層に$In_xGa_{1-x}N/GaN$多重量子井戸構造が用いられており、発光波長の更なる長波長化に向けてIn組成をより高くすることが精力的に進められています。しかしながら、$In_xGa_{1-x}N/GaN$の格子不整合に起因する結晶性劣化やピエゾ電界効果による発光効率の低下が大きな問題となっています。

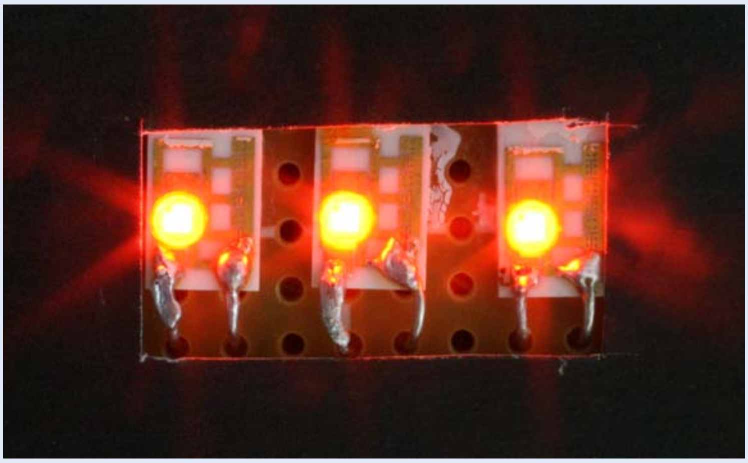
我々は、有機金属気相エピタキシャル（OMVPE）法を用いて、Ⅲ-Ⅴ族半導体中で希土類元素を原子のレベルで操ることにより、新しい物性・機能を効果的に発現させるとともに、それらを有効に活用した新規デバイスを創出することを目指しています。これら一連の研究の過程で、我々は赤色蛍光体の発光中心として広く用いられているEuイオンに着目し、OMVPE法により高品質なEu添加GaNを作製するとともに、それを活性層とした赤色LEDの室温動作に世界で初めて成功しています。その後、赤色LEDからの光出力は増大の一途を辿り、現在では20mA駆動においてサブmWに達しています。実用化には更なる高輝度化が求められるものの、本発明により同一基板上への三原色LEDの集積化が可能となり、超小型高精細LEDディスプレイや次世代LED照明などの実現が期待されます。

Light-emitting diodes (LEDs) have garnered attention as eco-friendly devices used in displays, lighting, and other equipment to help conserve energy and reduce CO_2 emissions on a global scale. After the groundbreaking invention of blue and green LEDs employing nitride semiconductors ($In_xGa_{1-x}N/GaN$), which was the subject of the 2014 Nobel Prize in Physics, full-color large-screen LED displays could be developed by combining these blue and green LEDs with conventional red LEDs ($In_xGa_yAl_{1-x-y}P/GaAs$). These displays are now ubiquitous in cityscapes.

Blue LEDs can also be combined with yellow phosphor to produce ultra-small, ultra-light white LEDs that have long lives and are easily driven. White LEDs are used as backlighting in color liquid-crystal displays (LCDs) to take full advantage of these features. Furthermore, with the recent improvements in the brightness and efficiency of white LEDs, conventional incandescent bulbs and fluorescent lights are rapidly being replaced with LED lighting.

Against this backdrop, there has been a strong demand to develop red LEDs using nitride semiconductors. Blue and green LEDs employing an $In_xGa_{1-x}N/GaN$ multiple quantum wells (MQWs) structure for the light-emitting layer have already become commonplace, and researchers are aggressively pursing a quantum well structure with higher indium content aimed at producing even longer wavelengths. However, lattice mismatch with $In_xGa_{1-x}N/GaN$ leads to crystal degradation and the efficiency of light emission is greatly limited by piezoelectric fields.

We have developed new properties and functions with rare-earth (RE)-doped III-V semiconductors grown by atomically-controlled organometallic vapor phase epitaxy (OMVPE) to create new devices that make effective use of these properties and functions. Throughout the course of our research, we have focused on europium (Eu) ions that have been widely used as an activator for red phosphor, and have succeeded in growing Eu-doped GaN layers with high crystalline quality by OMVPE, as well as developing the world's first red LED that operates at room temperature using Eu-doped GaN as the active layer. Since then, we have steadily increased the light output from our red LEDs and at present have achieved a sub-mW output level at an injected current of 20 mA. While still greater brightness is required for the red LEDs to become practical, this invention will enable LEDs of the three primary colors to be integrated on the same substrate, which could lead to the development of ultra-small, high-resolution LED displays and next-generation LED lighting.



Eu添加GaNを用いた窒化物半導体赤色LED
Eu-doped GaN red LED

Voice of Foreign Researchers at the Photonics Center

Photonics Center promotes internationalization of Osaka University to become a world center for photonics innovation

座談会 フォトニクス研究を国際的に展開するには

International collaborations and human resource exchanges are important

Hidekazu ISHITOBI

Let us begin the roundtable talks.

We want to discuss what do you expect from Osaka University to improve to provide a better environment of study from the point of view of foreign researchers?

Prabhat VERMA

I personally have one obstacle which I have felt all the time and that is language. The very important point about foreigners getting into the research here is to overcome the language barrier.

The very first point that I would like to raise is not only about Osaka University, but in general it is true that when we want to encourage research done by foreigners in Japan, the incorporation of international language like English, is very important not only in the lab, because in most cases a small group talks and works in English, but there are so many documents, official processes, and so many things that are completely in Japanese language.

Almar F. PALONPON

Since my impression of Osaka University is that of an international university, I was surprised to see that all the documents for signing the contract were still in Japanese, which I could not read.

Yanjun LI

Although I can speak Japanese, I am not required to carry out my research in Japanese. Although Osaka University is one of the top universities in Japan, it needs to improve ability in English.

VERMA

Whenever we discuss about foreign researchers and internationalization, it is always about communication, which depends on how good we can exchange our ideas and tell others what we are doing and learn what others are doing. As communication is really important, language becomes more important.

Increase use of English not only in the lab but also in documents, official processes, and others

ISHITOBI

Can you discuss why or for what purpose international collaboration is necessary, especially in photonics?

VERMA

These days, photonics is coming up with a very good importance. For example, light is a source of energy, which is available for free and can be used for many purposes. We need to develop the techniques. In that case, if we have ideas and we put them together, then something new will come up. In Europe, countries not have only their own individual projects, but they have European Union projects where people are funded from different countries under the same project and they work together to bring something new and it is quite successful. Since Japan is an island away from the rest of the world, we need to be more enthusiastic and aggressive to do such collaborations.

PALONPON

One of the research directions is how to use photonics, what applications of photonics can benefit mankind. If we just rely on the field of photonics, we do not see what we can do with photonics but if we talk to a chemist, a biologist, or scientists from other fields then there is a chance to come up with research that is really multidisciplinary in nature and which can develop photonics as a very good research field with many applications.

ISHITOBI

What about the development of human resources?

VERMA

We are sitting in the Photonics Center, which has one very prominent international committee to have collaborations internationally, and it also has another running project within Asia, called the Asian CORE Program. I am the chairperson of this international committee and vice-chairperson of the Asian CORE Program.

For international collaboration, there is another team which is looking after center-to-center or university-to-university collaborations. The Asia CORE is only within Asia and is between professors, whereas this is all over the world, between universities where we have signed some MOUs and are going to sign more. Photonics Center is also helping to have MOU between Osaka University and other universities. This is something that is already going on here. We are exchanging human resources because students and young researchers are traveling for collaborations and we are having joint conferences. This is already a good step and probably we should do that more at the university level.

PALONPON

I recently went to the Philippines. I was invited by the National Institute of Physics, University of Philippines Diliman as a speaker in their congress as they have a local association of physics. When I attended it, the collaboration between Japan and Philippines was clearly visible. Many Japanese professors like Professor Araki and Professor Hashimoto were there. There were some other professors from different universities. There is a good connection between University of Philippines Diliman and Japan.

VERMA

This year, we are planning to have an international conference on Tip-Enhanced Raman Spectroscopy in Osaka. We will be organizing that and I am sure Photonics Center is getting involved very seriously into it. These activities are important to know each other.

Dr. Prabhat VERMA
Professor
Department of Applied Physics
Graduate School of Engineering

Dr. Yanjun LI
Assosiate Professor
Department of Applied Physics
Graduate School of Engineering

Dr. Almar F. PALONPON
Lecturer
Photonics Advanced Research Center
Osaka University

Dr. Hidekazu ISHITOBI
Assistant Professor
Graduate School of Frontier Biosciences

Voice of Foreign Researchers at the Photonics Center

ISHITOBI

For Osaka University to be internationalized, a clear purpose is necessary and I ask you why and what purpose would make that point clear internationally.

VERMA

There are always two aspects for the development in science. One is that you become a very famous scientist, achieve a Nobel Prize and everything is in your name. The other is we do something together for the humanity and make the world better for everybody using science.

On one hand, we want to do everything by ourselves and take all the credits, but this may come along just by chance. There is a very low possibility of much success and development by one person individually. On the other hand, we can collaborate with many people globally and everybody works together for the betterment of the whole humanity.

In that sense, internationalization is really important where we can take everybody and go ahead together finally to achieve something good for everybody. Science has no particular aim. I do not say that I have to achieve this particular solution and then I get the Nobel Prize. That is not the aim. The aim of science is to make the world better to understand nature and to use things that are available in nature for the betterment of humanity.

ISHITOBI

Please give some suggestions to make Osaka University more open.

VERMA

We have raised and agreed on two points. First is that communication is very important and for that somehow language makes a barrier. We have to improve the communication not only for science but also for the other things related to science, which is administration inside the university, funding, etc. Second is international collaboration. More involvement of foreigners into our university, and our university students and researchers should go out more to foreign universities. Exchange, international collaboration and communication are very important. Osaka University is on the right path but we need to make it better.

国際光年 2015 への取り組み

The International Year of Light and Light-based Technologies 2015

INTERNATIONAL YEAR OF LIGHT 2015

国際連合（UN）総会第68回セッション(2013年12月)において、2015年を光とその技術の国際年（IYL2015）とすることが宣言されました。

光は、科学、技術、芸術、文化の中心にあり、その技術は社会の発展に資することが挙げられ、ユネスコが関わります。光は、また、ユネスコのアフリカ重点政策の、教育と男女平等向上に資することが挙げられています。

2015年は、1815年のフレネルの光の波動説や、さらにはIbn Al-Haythamが著した光学の本の1000年も過去に遡るマイルストーンに因んでいます。昨年のノーベル化学賞、物理学賞がともに光の科学と技術にかかわるものであったことも国際光年の意義を高めていると言えましょう。

大阪大学フォトニクスセンターは、フォトニクスによるイノベーションが国際光年の趣旨と一致しており、様々な行事を開催し、スポンサー（Associate Sponsor）となってこれを積極的に支援します。1月のパリの国際光年オープニングセレモニーで以下のフォトニクスセンターチラシを配布しました。未来戦略機構の国際シンポジウムOpto Osaka 2015もIYL2015の一貫として開催されました。

On 20th December 2013, The United Nations General Assembly 68th Session proclaimed 2015 as the International Year of Light and Light-based Technologies, IYL2015.

UNESCO supports IYL2015 and it is pointed out that;

- Light is central to science, technology, art and culture,
- the promotion of UNESCO's Priorities for Africa with focus on Education for All and Gender Equality,
- Light technology drives development.

Number of important milestones; In 1815, Fresnel published his first work introducing the theory of light as a wave and 1000 years ago, Ibn Al-Haytham published a book on vision, optics and light in Arabic. It is worth to mention that both Nobel Prizes in Physics and Chemistry in last year were on sciences and technologies of light.

Our mission, innovation by photonics is, we consider, along in the same direction with the spirit of the IYL, the Photonics Center, Osaka University is going to actively support IYL2015 by holding a variety of events and become a sponsor (Associate Sponsor). We have distributed the following flyer at the opening ceremony in January at Paris.

Osaka University is on the right path but we need to make it better

PALONPON

One thing that I would like to add on how to attract foreign researchers to work in Japan, not just in Osaka University, is the system in Japan should be able to meet the needs of foreign researchers, who have a family.

VERMA

Some universities in Europe have a system where they invite foreigners for 6 months, 1 year or for a shorter period and help their children and family settle down. For example, they help in finding suitable job for their spouses or suitable schools for their children. If the university takes this responsibility, the foreign researcher feels comfortable to go to that university. But when they come to Japan, they ask themselves what will happen to my children and my family and then they hesitate to take up the short term research opportunities here.

This is one very important point that you raised. The university has to think about having more facilities available to invite good researchers. If we invite somebody to do research, they want to come here with a similar life style that they have in their own countries and if we provide that facility they will be willing more to come here.

Another important point that I have noticed in the USA, and probably also in Europe, is that the universities negotiate salaries with good professors. A professor, who is very productive and doing very good research, is hired by the university by offering a higher salary. If better facilities and salaries are offered, nobody will say that they do not need money. Then, one can always attract better people. This negotiation of salary is very common in the USA. The Japanese universities should also learn something like that, then they can attract more people. Otherwise people will think if they are here or there, it is all the same.

If there is incentive in moving to Osaka University, maybe people from Tokyo University or other universities who are very good will come to Osaka and will do their research here. That is one thing that universities should consider. This is true for not only foreigners but for everybody.

ISHITOBI

Osaka University has now established a system wherein they invite a limited number of foreign researchers on high salaries.

VERMA

What I am saying is if we are doing good research or publication, then we should get incentive for doing that so that we are motivated to do better research in that particular place. For example, we saw this Nobel Prize in blue LED last year. The person who developed blue LED received many invitations, because everybody knew that one day this would get a Nobel Prize as this was a great and practically a very useful invention. University of California grabbed him with higher salary, even if he had no experience in teaching and no connections with the university. This policy to take good people to your place is very important.

LI

Salary is one factor, but the other factor is if we do not have good equipment, we cannot do good research. For me, why I chose Osaka University? It is because Osaka University has top equipment so I can do my research. If the university gave a good salary but did not have good equipment, I cannot do good research.

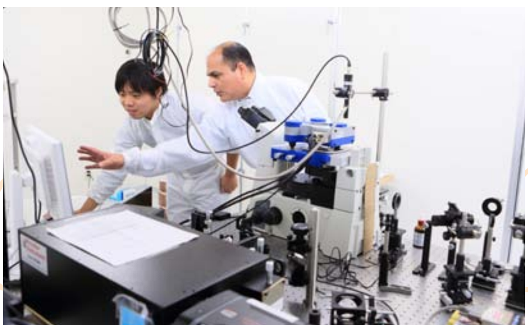
VERMA

In this point also, international collaboration becomes very important. Some of the machines are so expensive and huge that not everybody can buy. Even if it exists in some university in some other country, if we have good collaboration, if we have exchange people, we can go there and utilize their machines and they can come here and utilize our machines. In that sense, international collaboration or exchange plays a very important role in the development of science.

ISHITOBI

Let's work together to make Osaka University be the world center for photonics innovation. This year, 2015 is the International Year of Light.

Voice of Foreign Researchers at the Photonics Center



Why promote Photonics at Handai and Japan

Zouheir SEKKAT
Director
Optics and Photonics Center, MAScIR
Professor
Mohammed V University, Rabat, Morocco

Optics and photonics are the science and application of light. Photonics uses light to advance modern technologies encompassing security/safety technology, astronomy, medical imaging, biometric security, communication, displays, manufacturing, robotics and so on. The vital role photonics plays in innovation and economic growth can be seen at modern-day technologies, which have been made possible largely by photonics. Photonics is everywhere : computer, TV, phone, and so on. In Europe, the European technology platform Photonics21 represents the European photonics community of industry and research organizations. Their members develop a common photonics strategy for future research and innovation in Europe. The US has launched a National Photonics Initiative. Both US and Europe, created photonics initiatives for addressing their nations major challenges ; i.e. economic growth and the creation of jobs, through strengthening its innovation capacity.

Asia, and Japan, in particular, should be no exception in promoting and launching a national photonics initiative with the aim of securing Japan's industrial leadership and economic growth, a highly skilled workforce, and the capability to generate new jobs that attract young people, and act as a basis of the new Public Private Partnership. Japan's innovation capacity in photonics will substantially contribute to boost its economy and thus benefit Japanese citizens. Japan National Photonics Initiative (JNPI) should focus on key technology areas, including security/safety, communications and information technology, manufacturing, health, and energy.

Osaka University has created the Photonics Advanced Research Center (PARC), which is a wonderful initiative and the mecca of optics and photonics in Japan. PARC is world class research center where top level research activity is carried in many different fields of photonics with a very strong tie with industrial partners. According to my experiences of working at the Institute of Optics at Orsay University, Paris, France, and the Max-Planck Institute for polymer Research, Mainz, Germany, and the triangle Stanford University, IBM Almaden and the University of California, Davis, CA, USA, I can tell that PARC is very well paved for international research and development. I firmly believe that JNPI should crystallize around PARC. I am now promoting joint research with PARC on functional nanophotonics to extend photonics to Africa for a global world of photonics.

researchers

大阪大学・モロッコフォトニクス国際共同研究の推進

JAPAN-MOROCCO HANDAI PROJECT ON FUNCTIONAL NANOPHOTONICS

大阪大学国際共同研究促進プログラム「ファンクショナル・フォトニクス：ナノ光機能の探索と学術展開」を、河田　聡教授・フォトニクスセンターとZouheir Sekkat教授・モロッコ先端科学イノベーション研究機関(MAScIR)/The Optics & Photonics Centerセンター長で、2014年4月－2017年3月末の3年間推進します。本研究では、フォトンとナノ構造体の相互作用から生み出される新しいナノ光機能を探索し、その学術展開をはかります。ナノ領域での驚異的な光の増強、未知の非線形効果、金属などのプラズモニックな新奇効果、周波数・偏光を利用したナノ空間の計測・制御などが挙げられ、物理、化学、バイオメディカル、電気、デバイス等を分野横断的に共同研究・教育を推進します。モロッコ・阪大若手研究者の研究討論を重ね、研究教育ネットワークを強化し、ナノフォトニクスの人材を育成します。この研究教育は、大阪大学未来戦略機構第８光研究部門に資するものです。Sekkat教授は、大阪大学ではクロスアポイントメントにより研究・教育に携わります。

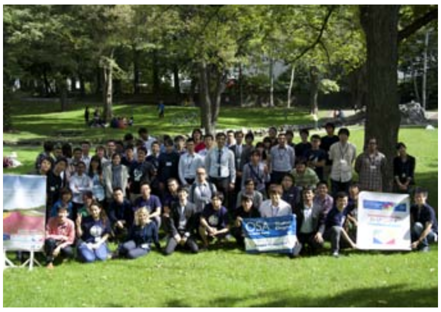
Launched is the Handai-Morocco joint project as one of the Handai projects for promoting international joint research, for three years: April 1st, 2014 - March 31st, 2017. The project is "Nano-functional Photonics: study of new nano optical/photonic functions originating from the interaction of photon and nano-structured materials" by Prof. Satoshi KAWATA and Prof. Zouheir Sekkat, Director, The Optics & Photonics Center, The Moroccan Foundation for Science Innovation and Research (MAScIR) and University of Mohamed V-Agdal, Rabat. We, in the fields of physics, chemistry, biotechnology, electronics, and devices jointly promote research and education on this new department crossing target: Nano-functional Photonics and contribute to development of the 8th division of the Institute for Academic Initiatives, Osaka University. Encouraged are to intimate research discussions among young researchers of the Moroccan Institute/University and Osaka University, expansion of research/educational network, and development of young talented nano-photonics researchers. Prof. Sekkat works by cross-appointment at Osaka University during his stay.

2014年12月 合同発表会にて
右から井上教授、セカット教授、相本理事、他共同研究者

学生カンファレンス IONS Asia 5 Hokkaido

2014年9月14日(日)～16日(火)　3日間
北海道大学クラーク会館

IONS Asia 5 Hokkaido
September 14-16, 2014 / Hokkaido University



9月14日(日)～16日(火)北海道大学クラーク会館にて大阪大学OSA/SPIE学生チャプター主催、"IONS Asia 5 Hokkaido"を"Asia Core Student Meeting"、"JSAP Student Meeting"と共同開催致しました。13カ国から総勢70名を上回る学生、若手研究者が集い、大規模な学生カンファレンスが行われました。

プログラムの企画・運営は学生が主体となって行い、参加者全員に楽しんで頂けるよう、バラエティに富んだプログラムが用意されました。招待演者として豊橋技術科学大学 エレクトロニクス先端融合研究(EIIRIS)副所長Adarsh Sandhu教授を招き、プレゼンテーション技術やネットワーク構築の重要性や意義をご講義頂きました。また日本応用物理学会会長 兼 大阪大学フォトニクスセンター センター長である河田聡氏やOSA Philip Howard Bucksbaum会長にもご講演頂き、さらに学生による口頭・ポスター発表、グループワークでは互いの意見の交換などが活発に行われ、とても有意義なカンファレンスとなりました。

若手研究者のさらなる国際ネットワークの拡充発展と、彼らの視野が拡がり将来の活躍に繋がることが期待されます

"IONS Asia 5 Hokkaido" was held for 3 days from September 14th-16th at Hokkaido University and was co-organized by OSA Student chapters of Osaka University and Hokkaido University. It was held jointly with the "Asia Core Student Meeting 2014" and "JSAP Student Meeting". More than 70 students and young researchers attended the conference from 13 countries making it one of the largest International student conferences in Asia in photonics field.

A variety of events and programs were planned by the OSA students Chapter members who managed this conference. For instance, invited speaker Professor Adarsh Sandhu, Deputy Director of the Electronics-Inspired Interdisciplinary Research Institute (EIIRIS) at Toyohashi University of Technology, gave a useful lecture for science and engineering based students on presentation skills and the importance of networking.

We hope that all participants had the opportunity through this conference to create networks beyond national boundaries and that these experiences will benefit them not only in their research field but also in many scenes of their lives and careers in the future.

第5回 こども科学の教室 スーパー光塾(ひかりじゅく) 君も光博士(ひかりはかせ)になろう！

The 5th "Super HIKARIJUKU" Kid's Photonics school
November 24, 2015 / 13:00-17:30
Osaka University Suita campus Icho-Hall

●2014年11月24日（月・祝）●13:00-17:30 ●大阪大学吹田キャンパス 銀杏会館

「光」の研究を行っている大学院生・学部生・若手研究者が中心となって「光」の特異性を分かりやすく且つ楽しく紹介するイベントで、今回で5回目の開催となりました。今年は、320名の応募者の中から当選した50名の小学生とその保護者が参加し、「光の直進性」や「全反射」等のキーワードをもとにした「光」の授業や実験を受講しました。

HIKARI-JUKU is an event where staff, made up of undergraduate, graduate students and young researchers, teach 4th to 6th grade pupils about the behavior of light. Fifty pupils and their parents participated and they were randomly selected from a group of 320 applicants.

大阪大学未来戦略機構国際シンポジウムOpto Osaka 2015

2015年1月14日(水) 13:00-19:00
グランフロント大阪B2F　ナレッジキャピタルコングレコンベンションセンター

The Institute for Academic Initiatives International Symposium "Opto Osaka 2015"
January 14, 2015 / 13:00-19:00 / Congrès Convention Center, Knowledge Capital, Grand Front OSAKA

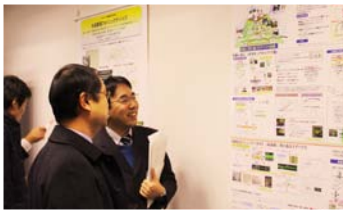
大阪大学未来戦略機構の主催により、Opto Osaka 2015が400名を越える来場者を迎え開催されました。大阪大学平野俊夫総長、文部科学省川上伸昭科学技術・学術政策局長、パナソニック株式会社代表取締役副会長・関西経済連合会副会長松下正幸様、総合科学技術・イノベーション会議久間和生議員のご挨拶の後、兒玉了祐教授より未来戦略機構光量子科学研究部門のご紹介があり、その後、インペリアルカレッジロンドンのSir John Pendry教授、スタンフォード大学のThomas Baer教授、阪大の河田聡教授の基調講演、Nicholas Smith准教授、Prabhat Verma教授、森勇介教授の講演が行われました。

This symposium opened with greetings from Mr. Toshio Hirano, the President of Osaka University; Mr. Nobuaki Kawakami, Director-General, Science and Technology Policy Bureau, MEXT ; Mr. Masayuki Matsushita, Vice Chairman of the Board, Panasonic Corporation, as well as Vice Chairman, Kansai Economic Federation; and Mr. Kazuo Kyuma, Member of the Council for Science, Technology and Innovation. After the greetings from the honorable guests, Prof. Kodama introduced the Division of Photon Science and Technology, of the Institute for Academic Initiatives. Following on from that, we had lectures from Prof. Sir John Pendry from the Imperial College, London, UK; Prof. Thomas Baer, from Stanford University, US; Prof. Satoshi Kawata; Assistant Prof. Nicholas Smith; Prof. Prabhat Verma; and Prof. Yusuke Mori. We welcomed over 400 visitors.

阪大フォトニクス・デイ2015

2015年2月2日(月) 13:00-19:30
大阪大学吹田キャンパス　フォトニクスセンター

Handai Photonics Day 2015
February 2, 2015 / 13:00-19:30 / Photonics Center, Suita Campus, Osaka University



起業・製品化をテーマにした今年度のフォトニクスデイでは、起業・製品化プロジェクトに採択された河田聡教授・森勇介教授・高原淳一教授・北野勝久准教授・民谷栄一教授・齋藤真人助教、尾崎雅則教授、藤田克昌准教授が合計9件の成果発表を行ないました。また、文部科学省科学技術・学術政策局の産業連携・地域支援課長の坂本修一氏、大阪大学産学連携本部総合企画推進部長兼知的財産部長の正城敏博教授、大阪大学ベンチャーキャピタル株式会社松見芳男代表取締役社長の産学官連携をテーマにした講演に120名の参加がありました。

This Photonics Day theme was "Entrepreneurial / Productization". In accordance with this theme, we were informed of nine accomplishments of Entrepreneurial / Productization Project in presentations by Prof. Kawata, Prof. Mori, Prof. Takahara, Associate Prof. Kitano, Prof. Tamiya, Assistant Prof. Masato Saito, Prof. Ozaki, and Associate Prof. Fujita. In addition, lectures about industry-academia-government collaboration were given by Mr. Shuichi Sakamoto, Industry-Academia Cooperation and area support Division chief, Science and Technology Policy Bureau, MEXT; Prof. Toshihiro Masaki, the Director of Planning and Promotion in Office for University-Industry Collaboration; and Mr. Yoshio Matsumi, the President of Osaka University Venture capital Co., Ltd. We had 120 participants and ended Photonics Day on a high note.

大阪大学フォトニクス先端融合研究拠点
〒565-0871 大阪府吹田市山田丘2-1 フォトニクスセンター（P3）
Photonics Center, P3, Suita, Osaka 565-0871 Japan
Tel: 06-6879-7927　Fax: 06-4864-2695
E-mail: parchq@parc.osaka-u.ac.jp
http://www.parcjp.org/
Photonics CENTER

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