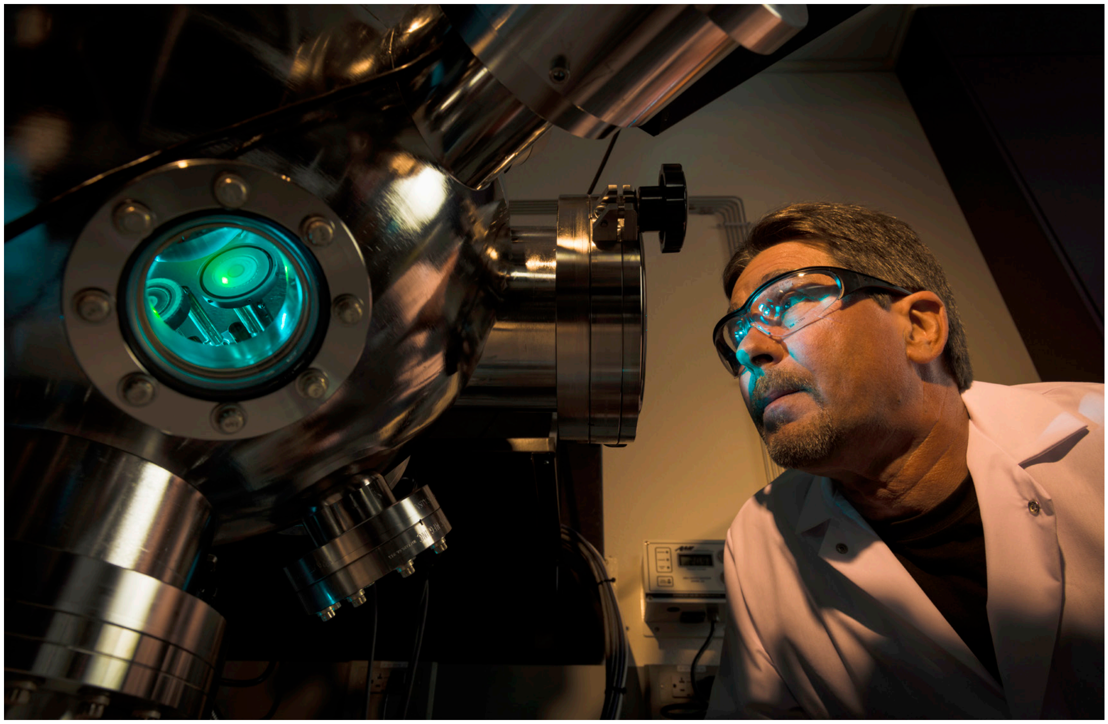
LA-UR-17-28826
Approved for public release; distribution is unlimited.

Title:	MPA Materials Matter October 2017
Author(s):	Kippen, Karen Elizabeth
Intended for:	Newsletter Web
Issued:	2017-09-28

October 2017
Approved for public release;
distribution is unlimited.

MPA Materials Matter

INSIDE



Paul Dowden peers into the viewport of the dual-laser pulsed laser deposition system to verify beam alignment on the target.
Photo by Michael Pierce (XIT-TSS)

Paul Dowden

Focusing his talent on constructing a unique laser application

By Kris Fronzak, ADEPS Communications

From his wallet, Paul Dowden produces a photo of his daughter, then about four years old. She's perched in the driver's seat of a 1,400 horsepower alcohol-fueled dragster he built from scratch. Dowden has applied his skillful hands to cars for decades. He's worked as an auto and diesel mechanic and is a hot rod enthusiast, doing his own fabrication, electronics, and engine and transmission building.

During freshman orientation at Indiana's Vincennes University he discovered his passion for building could be tuned to an entirely different field: lasers. Dowden oversees all pulsed laser deposition (PLD) operations for the Center for Integrated Nanotechnologies at Los Alamos (MPA-CINT) and built a novel dual-laser PLD system that's just gone online there. He calls lasers one of the most versatile tools ever invented, with applications "from the mundane to most exotic scientific research."

> *"When I first entered the field, lasers were looking for applications; now the number of applications is innumerable."*

continued on page 3

Los Alamos
NATIONAL LABORATORY
EST. 1943

From Tanja's desk . . .

The news of the shipping incident hit the Lab late on Friday June 23—at the same time I was in the emergency room after a bicycling accident on my ride home. While my wounds have healed, the Laboratory has not yet returned to "normal"—that is, pre-incident shipping procedures.

By now, most of you are very familiar with the new procedures. The most significant change is that the responsibility to declare a shipment non-hazardous has shifted to your group leader, whose signature is now required (and automatically routed using the ShipIt online form). The easiest way to check the hazard state of a material is to check the transportation section of the corresponding safety data sheet (SDS). Most chemical suppliers link to the MSDS from their websites, and you can also find them at the "(MSDS)online" portal on the Lab's Shipping Guidelines or Chemical Safety web pages. The information on the data sheets is drawn from 49CFR172.101, the hazardous material table that serves as the ultimate reference. Please work with your group management to assess the hazard state of materials that you ship—your gut feeling may be incorrect!

Hazardous materials require an exception memo (see int.lanl.gov/services/materials-management/shipping/shipping-guidelines.shtml). Hazardous shipments have to be cleared by our Site Office through PADSTE, and ADEPS is submitting requests on Tuesdays. So, for hazardous shipments it is best to plan ahead! Please work with your group leadership to create the memo and get it submitted via MPA-DO.

In addition, hand-carry of non-hazardous materials still requires ADEPS tracking through a simple memo with which your group leader will help you. Hand-carry of hazardous materials is subject to the same procedure as all hazardous materials. Also here it is best to plan ahead!

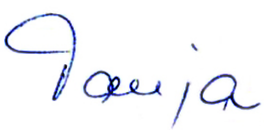
The shipping incident was a wake-up call and prompted the Laboratory as a whole to critically evaluate all its processes and procedures and look for opportunities to continue to make our Lab a safer and more secure place at which to work. As our Director stated, LANL broke DOE's trust in us and it will take time to rebuild. All of us must help in this process, and we encourage you to share ideas and suggestions with your group management. Please do realize that many processes are outside the purview of MPA to control, but we'll do our best to champion your ideas.

While we are challenged with the process changes associated with shipping, we are more proud than ever of the continued excellence of MPA staff. Three of our scientists won LDRD-DR awards (congrats to Neil Harrison, Abul Azad, and Aditya Mohite and their co-investigators) and nine MPA scientists will lead 10 new LDRD-ER awards (congrats to all!*). Two of our scientists and their teams, led by Piotr Zelenay and Eric Brosha, are selected as R&D 100 finalists, another tremendous accomplishment. We anxiously await the outcome and keep our fingers crossed. In addition, as reported in every issue of *Materials Matter*, many of our scientists receive national and international recognition through professional societies and other venues, and we congratulate all of them. We are immensely proud of our exceptional MPA workforce—the article featuring Paul Dowden from CINT is a case in point, demonstrating how MPA's scientific accomplishments are facilitated by our remarkable cadre of professionals—often the unsung heroes who enable our scientists to be so successful!

MPA Division Leader Tanja Pietraß

*Marc Janoschek, Sergei Ivanov (two awards!), Brian Scott, Mun Chan, Rohit Prasankumar, Peter Goodwin, Dmitry Yarotsky, John Singleton, Houtong Chen

“*While we are challenged with the process changes associated with shipping, we are more proud than ever of the continued excellence of MPA staff*”



Dowden cont.

Dowden's experience in the field began fortuitously, when he walked out of the school's mechanical engineering department mid-orientation and happened upon the laser and electro-optics department. One of its professors had worked at Los Alamos National Laboratory, which led to Dowden's discovery of the Department of Energy-funded Antares Laser Research program, a large laser system built to achieve fusion. "My goal became working on the Antares laser. I would've done anything to get my foot in the door," Dowden said.

He joined the Lab in 1983 as a contract electronics technician, after graduating top in his class. When a position to complete Antares's multi-line carbon dioxide oscillator materialized, he jumped on it, becaming a Los Alamos laser optical technician.

Now a technologist in MPA-CINT, Dowden's latest achievement is the unique dual-laser PLD system that features both ultrafast and excimer lasers. This versatile system allows researchers to grow thin films ranging from tens of nanometers to micrometers in thickness. It's ultra-customizable, using multiple targets, different gases, unique wavelengths, specific configurations, and offering a variety of laser parameters. The system grows functional materials ranging from oxide thin films to heterostructures, superlattices, and nanocomposites—which have applications in high sensitivity sensor devices, storage devices with ultra-low power consumption, and energy storage with high power density.

Putting to work his expertise in complex mechanical and optical systems, Dowden conceptualized and constructed a stabilized, imaged beamline for PLD systems that was key to overcoming the drawbacks of a traditional, single lens focus for repeatable PLD film growth. The new beamline, part of the larger system, earned him a 2016 U.S. Patent. For the system, Dowden also created a patent-pending ultra-clean substrate heating device, which operates without any braze materials and reaches 1000 ºC.

Dowden is more than a mechanical engineer, said longtime collaborator and former CINT Center Leader Quanxi Jia (The State University of New York at Buffalo). "He knows about the electronics, mechanics, and vacuums and can get his hands almost everywhere. I don't see many techs who are so versatile or have such broad experience."

Dowden has constructed chemical lasers, helped develop an early ultrafast dye laser, and was part of a team that won an R&D 100 Award for flexible superconducting tape (please see "Paul Dowden's favorite experiment" below).

"When I first entered the field, lasers were looking for applications. Now the number of applications is innumerable. I have worked with so many types of lasers here at the Lab, which would not have been possible in private industry," he said.

Dowden's PLD systems and improvements bring a new capability to CINT, a DOE Office of Basic Energy Sciences national user facility jointly operated by Los Alamos National Laboratory and Sandia National Laboratories. The instruments are available to outside researchers through CINT user agreements.

Paul Dowden's favorite experiment

What: Developing flexible, high-temperature yttrium barium copper oxide (YBCO) superconductor architecture and a method for deposition onto flexible, long-length, metal tape substrates.

Why: High critical current superconducting materials that operate at liquid nitrogen temperature vs. liquid helium and can be fashioned into a cable or magnet configuration are highly desirable. They have a low cost of operation and high-efficiency power transmission compared to conventional conductors such as copper or aluminum.

When: 1995-2000

Where: Los Alamos National Laboratory's Superconductivity Technology Center

Who: Dean Peterson, Jeff Willis, Paul Arendt, Steve Foltyn, Paul Dowden, Ray Depaula, Randy Groves, and other contributors

How: High-rate pulsed laser deposition (PLD) of YBCO on continuously moving, ion-beam-assisted-deposition-coated, 1-centimeter-wide stainless steel alloy tape.

The "a-ha moment:" After growing several thousand YBCO films on single crystal substrates it was discovered that an oriented, "template" layer could be grown on polished metal strips by ion beam assisted deposition. This 0.005"-thick tape could then be utilized as a substrate upon which to grow YBCO in a continuous fashion. After much trial and error in a Los Alamos-built PLD chamber, we finally produced a meter-long section that was superconducting from end to end.

Although the first meter only carried 1 ampere through the 1-micron thick/1-centimeter-wide film, it was a huge success. The concept worked. As a team, we proceeded to increase the current-carrying capabilities to hundreds of amps, far exceeding the capability of standard conductors by many orders of magnitude. This team effort over several years and the science we worked so hard to accomplish was by far my favorite experiment.

MPA staff in the news

Baker recognized with fellowship, distinguished student award

Graduate Research Assistant Andrew Baker (Materials Synthesis and Integrated Devices, MPA-11) is the recipient of the Bill N. Baron Fellowship from the University of Delaware and a 2017 Los Alamos Distinguished Student Award.

Fellowship recipients must perform exceptional supervised research in engineering, science, or energy policy in the renewable energy field.

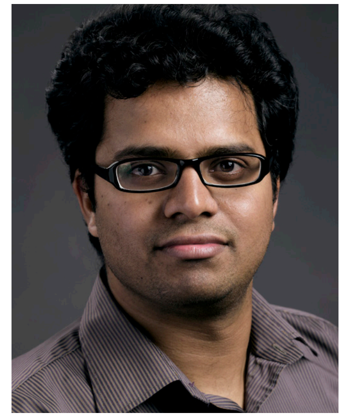
Baker works with Rod Borup (MPA-11) as part of the Fuel Cell Consortium for Performance and Durability project, a Department of Energy-funded consortium led by Los Alamos. The project's goal is to demonstrate world-class improvements in fuel cell performance and durability that exceed the DOE's targets for 2020. Baker's role involves understanding mechanisms of cerium radical scavenger migration in order to enhance fuel cell durability and mitigate performance losses. The Baron Fellowship recognizes this work and research performed at the University of Delaware using carbon nanotubes to improve the mechanical properties of polymer electrolyte membranes.

Dusan Spernjak (Applied Engineering Technology-1, AET-1) nominated Baker for the student award, recognizing him for his ability "to generate and execute a variety of research-related tasks, both inside and outside of the laboratory setting, with very little oversight." In addition to his fuel cell research, Baker has contributed to the Lab's additive manufacturing efforts by helping conduct research in characterizing material properties of additively manufactured parts.

Baker, a PhD candidate in mechanical engineering at the University of Delaware, joined the Laboratory in 2014 to continue his dissertation studies on polymer electrolyte membrane (PEM) fuel cell durability. At the 2015 Fuel Cell Seminar and Energy Exposition in Los Angeles, he won a Best Poster Award for his research into cerium migration during PEM fuel cell operation and a second-place Bernard Baker Student Award for fuel cell research.

Technical contact: Andrew Baker

Chillara recognized for exceptional research presentation at DisrupTECH



Vamshi Chillara's proposal to use ultrasound to power medical implants was recognized with the "Most Fundable" award among postdoctoral researchers at Los Alamos's third annual DisrupTECH event.

Chillara (Materials Synthesis and Integrated Devices, MPA-11) holds a PhD in engineering science and mechanics from The Pennsylvania State University. His research broadly encompasses the development of ultrasonic sensors and sensing systems for structural, chemical, and biomedical applications; damage prognosis and health management; soft and smart sensing/actuation schemes; acoustic metamaterials and nonlinear phononics, and wave propagation in complex media. He is keen on applied research that enables technology transfer and product development. He is a member of MPA-11's Acoustics and Sensors team.

DisrupTECH brought together investors, business leaders, and others in the community to learn about potentially disruptive technologies—those that could potentially change the way we live and work—being developed at the Lab. Five Los Alamos staff scientists and six postdoctoral researchers presented pitches for different technologies to a panel of judges comprised of industry experts and venture investors.

Also pitching an idea at the event was Chris Leibman (MPA-11) who proposed developing a chemical processing inlet for isotope ratio mass spectrometry of uranium isotopes, thereby enhancing world security.

The event was hosted by Los Alamos's Richard P. Feynman Center for Innovation, the New Mexico Angels investor group, and the New Mexico Start-Up Factory. Sponsors included title sponsor EY, the State of New Mexico Economic Development Department, the New Mexico Manufacturing Extension Partnership, the Los Alamos Commerce and Development Corporation, the County of Los Alamos, and the City of Albuquerque.

Technical contact: Vamshi Chillara

continued on next page

MPA staff cont.

Copp receives University of California President's Postdoctoral Fellowship

Stacy Copp (Center for Integrated Nanotechnologies, MPA-CINT) has been chosen for a University of California (UC) President's Postdoctoral Fellowship.

This fellowship was established in 1984 to encourage outstanding women and minority PhD recipients to pursue academic careers at the University of California (UC). The program offers postdoctoral research fellowships, professional development, and faculty mentoring to outstanding scholars in all fields whose research, teaching, and service will contribute to diversity and equal opportunity at UC.

In 2012, the UC-affiliated national labs were formally invited to partner with the UC Office of the President to offer UC President's Postdoctoral Fellowship opportunities in science, technology, engineering, and mathematics, coupled with mentoring, professional development and networking opportunities at their respective laboratories.

Copp completed her PhD in physics at the University of California, Santa Barbara, studying the optical properties and nanoscale arrangement of DNA-stabilized silver clusters. She was an undergraduate intern for two summers at the Center for Integrated Nanotechnologies at Los Alamos. Copp joined the Lab as a Director's Postdoctoral Fellow in January.

Her fellowship research focuses on designing and understanding biomimetic polymer materials that form novel photonic structures through self-assembly, with applications in light harvesting and artificial cells.

Technical contact: Stacy Copp

Kreller wins Electrochemical Society's J. B. Wagner Award

Cortney Kreller (Materials Synthesis and Integrated Devices, MPA-11) has received The Electrochemical Society's (ECS) High Temperature Materials Division J. Bruce Wagner, Jr. Award.

The award, established in 1998, recognizes a young ECS member who has shown exceptional promise for a successful career in science or technology in the high temperature materials field. Award criteria include a body of scientific or technical work deemed to have a significant positive and a long-lasting impact in high temperature materials. As part of the award, which is named for a former ECS president, Kreller will deliver a keynote talk at a High-Temperature Materials Division-sponsored symposium.

Kreller earned a PhD in chemical engineering from the University of Washington, where her graduate research focused on the measurement and modeling of nonlinear rate processes governing the performance of solid oxide fuel cell cathodes. Prior to joining the Laboratory as a postdoctoral researcher in 2011, she conducted postdoctoral work at Imperial College, London.

Kreller's research interests include electrochemical sensors, electrosynthesis of fuels, intermediate temperature fuel cells, and the interplay of crystalline disorder and ionic transport. She has co-organized symposia at ECS conferences and is a member-at-large of its High Temperature Materials Division.

ECS is a U.S.-based professional association with more than 9,000 members in more than 75 countries. Its mission is to advance theory and practice at the forefront of electrochemical and solid-state science and technology, and allied subjects.

Technical contact: Cortney Kreller

continued on next page

MPA staff cont.

Mukundan joins ranks of Electrochemical Society Fellows

Rangachary (Mukund) Mukundan (Materials Synthesis and Integrated Devices, MPA-11) was selected as a 2017 Electrochemical Society (ECS) Fellow. The distinction, granted to no more than 15 people annually, was established in 1989 to recognize advanced individual technological contributions in electrochemical and solid-state science and technology.

Mukundan's research focuses on fuel cells, electrochemical gas sensors, and energy storage devices. He is a steering committee member for the Department of Energy's Fuel Cell Consortium for Performance and Durability (FC-PAD), where he coordinates the thrust area operando evaluation—benchmarking, accelerated stress testing, and contaminants.

He is the co-inventor of 6 U.S. patents, has authored more than 125 papers, and is the principal investigator of a 2017 Los Alamos Laboratory-Directed Research and Development project, "Flow cells for scalable energy conversion and storage."

Mukundan received the Electrochemical Society's 2005 J.B. Wagner Award of the High Temperature Materials Division and the 2016 Sensor Division Outstanding Achievement Award, the highest recognition the division can bestow on an ECS member. He is also the technical editor for ECS journals in the area of sensors and measurement sciences, and previously served on the board of directors (2006-2008) and as chair of the Sensor Division (2006-2008). He earned a PhD in materials science and engineering from the University of Pennsylvania, and joined the Lab in 1997 as a postdoctoral fellow.

The Electrochemical Society is the world's largest professional society for electrochemical science and applications. Mukundan will receive his award at its fall meeting in Washington, D.C.

Technical contact: Rangachary Mukundan

Pound receives Los Alamos Distinguished Student Award

Benjamin Pound (Center for Integrated Nanotechnologies, MPA-CINT) is the recipient of a 2017 Los Alamos Distinguished Student Award. The annual awards, sponsored by the Student Programs Advisory Committee and the Student Program Office, recognize outstanding performance by Lab students.

Pound, a graduate research assistant, was nominated by his mentor Richard L. Sandberg (Center for Integrated Nanotechnologies, MPA-CINT). Sandberg credited him with having "native curiosity about scientific and technical problems, the mathematical and physical intellectual depth, and the persistence and doggedness necessary to make him a first-rate experimentalist."

During his time in CINT, Pound has developed ptychography into a rapid nanometer-scale imaging technique at the Linac Coherent Light Source at SLAC National Laboratory, contributed to an Intelligence Advanced Research Projects Activity-funded imaging project, and aided development of x-ray lensless imaging microscopes using coherent diffractive imaging.

Pound, who joined the Lab in 2015 as a post-bachelor's student, was recently accepted into the University of California, Los Angeles Electrical Engineering Graduate Program. He is the recipient of an achievement award from the Lab's 16th Annual Student Symposium.

Technical contact: Benjamin Pound

Using light to align magnetic atoms in colloidal nanocrystals

Advances in the synthesis of magnetically-doped nanomaterials have sparked a renewed focus on low-dimensional magnetic semiconductors, which have interesting magnetic properties that can be greatly enhanced by strong quantum confinement.

The extent to which quantum confinement can enhance the spin interactions between carriers (electrons and holes) and embedded magnetic atoms is an area of significant current interest and has recently been studied in a variety of semiconductor nanostructures, including magnetically-doped nanoribbons, nanoplatelets, epitaxial quantum dots, and colloidal nanocrystals. The research appeared in *Nano Letters.*

Los Alamos scientists and collaborators recently demonstrated the use of an optical technique known as resonant photoluminescence (resonant PL) to reveal the formation of so-called "magnetic polarons" in CdSe nanocrystals doped with magnetic Mn^{2+} ions. A magnetic polaron forms when a single electron-hole pair (an exciton) causes the spontaneous ferromagnetic alignment of all the embedded Mn^{2+} spins in the nanocrystal—even in the absence of any applied magnetic field.

As depicted in the accompanying figure, the formation energy of the magnetic polaron can be directly revealed by the small energy shift between a pump laser (which creates the exciton) and the energy of the photons that are emitted by the excitons after the magnetic polaron has formed.

By studying these energy shifts as a function of both temperature and applied magnetic field, the strength of the microscopic magnetic interaction between the exciton and the embedded Mn^{2+} ions was inferred: about 10 tesla, in good agreement with theoretical estimates.

Furthermore, the detailed line shape of the resonant PL spectra provided direct insight into the statistical fluctuations of the Mn^{2+} spins. Their work highlighted the utility of resonant PL as an effective tool for detailed studies of collective magnetic phenomena in colloidal nanomaterials.

Researchers include W.D. Rice (University of Wyoming, former LANL postdoctoral researcher), W. Liu (former LANL postdoctoral student, now at Nanosys Inc.), V.I. Klimov (Physical Chemistry and Applied Spectroscopy, C-PCS), V. Pinchetti (Università degli Studi di Milano-Bicocca, Italy), D.R. Yakovlev (Technische Universität Dortmund, Germany, and Russian Academy of Sciences, Russia), and S.A. Crooker (Condensed Matter and Magnet Science-National High Magnetic Field Laboratory, MPA-MAG).

The work supports the Laboratory's Energy Security mission area and its Materials for the Future science pillar. A portion was funded by the DOE Office of Basic Energy Sciences and the Los Alamos Laboratory-Directed Research and Development program. The optical measurements were performed at the National High Magnetic Field Laboratory, which is supported by the National Science Foundation.

Reference: "Direct Measurements of Magnetic Polarons in $Cd_{1-x}Mn_xSe$ Nanocrystals from Resonant Photoluminescence," *Nano Letters* (2017).

Technical contact: S. Crooker

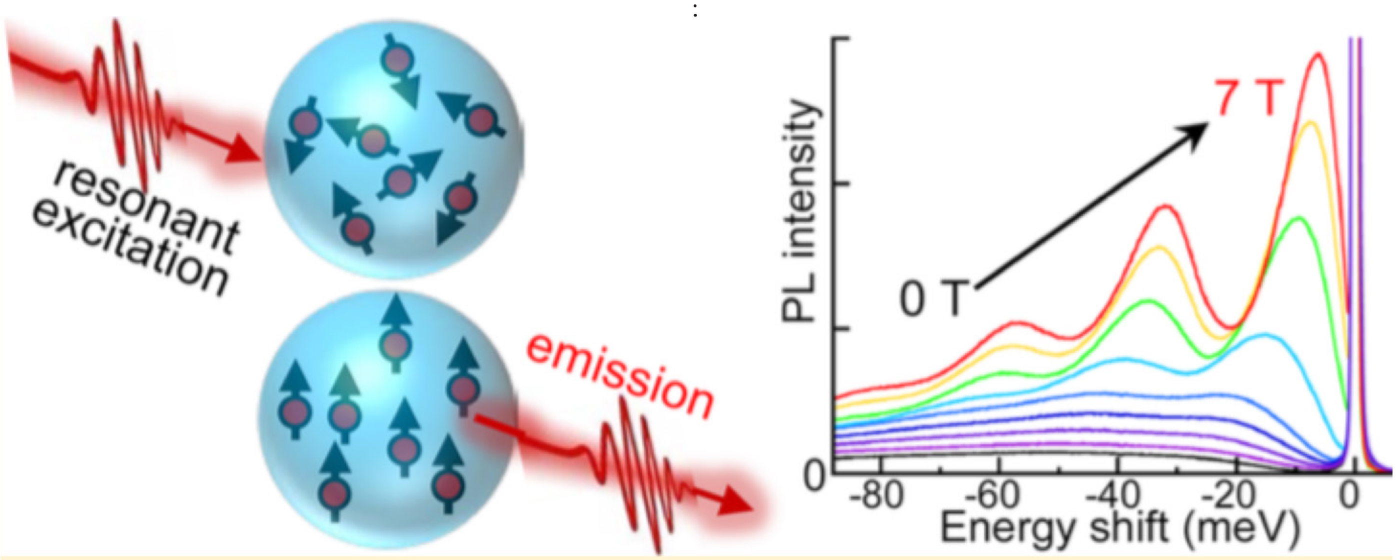


Illustration (left) depicts the formation of magnetic polarons in Mn-doped CdSe nanocrystals. Initially, the Mn^{2+} spins are randomly oriented. After the resonant pump laser photoexcites a single exciton, the exciton causes all the Mn^{2+} spins to ferromagnetically and spontaneously align. This lowers the exciton's energy. Therefore, when the exciton recombines, it emits a photon with slightly lower energy. The energy shift between the pump and emission energy reveals the polaron formation energy. The plot (right) shows how the resonant PL evolves with applied magnetic field.

Additive manufacturing hierarchical polymers for realization of emergent phenomena

A grand challenge in nanoscience integration is the ability to propagate the intrinsically unique behaviors of nanoscale materials into functional materials at the macroscale. The pursuit of functional nanocomposites that impact a wide range of technologies—from information processing to energy storage/transducing devices—has resulted in significant interest in the preparation of hybrid materials combining nanoparticles (NPs) with polymers. This effort includes working to achieve spatial-ordering of NPs within structured polymer matrices.

To achieve integration of these nanostructured polyelectrolytes with nanoparticles over a full range of length scales, Materials Physics and Applications and Materials Science and Technology division researchers used additive manufacturing to combine bottom-up self-assembly with top-down patterning to fabricate hierarchical, dynamic, mechanically durable materials possessing compliant interfacial chemistry for coupling to traditional device materials and architectures.

Two-photon polymerization (2PP) was applied for the multi-length scale patterning of nanostructured polyelectrolytes formed from self-assembled ionic liquid monomers—the first demonstration of the technique in fabricating a self-assembling, non-commercial monomer yielding patterned elements possessing internal nanostructure. The technique could yield more complicated structures and 3D constructs.

The resulting hierarchical soft materials will serve as scaffolding for the spatial localization and precise geometric patterning of nanoparticles required to develop versatile synthetic strategies and soft materials, enabling the hierarchical assembly of individual nanoparticles to harness their collective or emergent behaviors.

The research supports the Lab's Energy Security mission and its Materials for the Future science pillar, including its emergent phenomena theme by furthering efforts to tailor a material to perform in ways beyond its basic properties, thereby enabling controlled functionality, a central vision of the Laboratory's materials strategy.

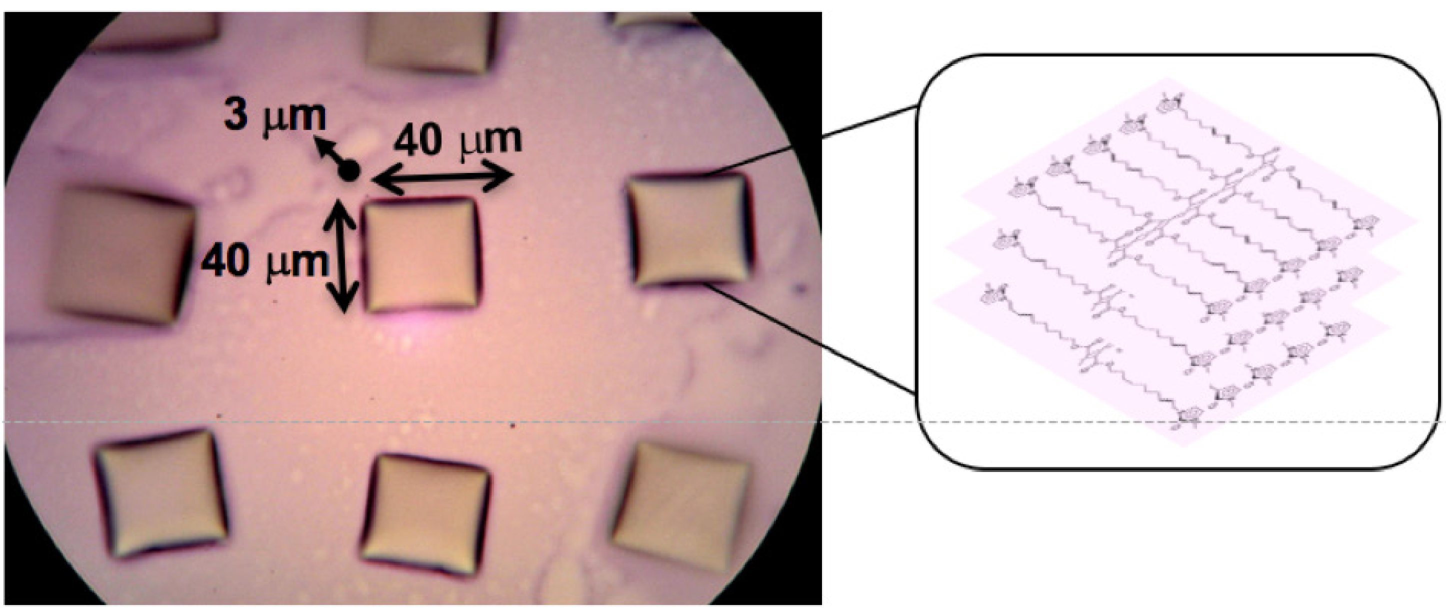
CINT is a DOE Office of Basic Energy Sciences user facility jointly operated by Los Alamos National Laboratory and Sandia National Laboratories. This work supports the Scientific User Facilities division of DOE BES through research in nanomaterials integration.

Researchers: Bryan Ringstrand, Chris Sheehan, and Millicent Firestone (Center for Integrated Nanotechnologies, MPA-CINT); Kim Obrey and Matt Herman (Engineered Materials, MST-7)

References: M.A. Firestone, S.C. Hayden, D.L. Huber, "Greater than the sum: synergy and emergent properties in nanoparticle–polymer composites," *MRS Bulletin* **40**, 760 (2015).

D. Batra, M.A. Firestone, "The effect of cation structure on the mesophase architecture of self-assembled and polymerized imidazolium-based ionic liquids." *Macromolecular Chemistry and Physics,* **208**, 1416 (2007).

Technical contact: Millie Firestone



Additive manufacturing combining bottom-up self-assembly with top-down patterning provides a means to achieve structures spanning millimeters to nanometers.

Triple-layering 2D perovskite sheets for solar cells improves efficiency by 12%

Perovskite photovoltaic cells, being inexpensive and easily manufactured, are undergoing intensive scrutiny and modifications to improve the stability and efficiency of solar cells and photovoltaic devices.

Laboratory scientists and international partners developed a strategy of layering perovskite into two-dimensional sheets that can be stacked using organic spacing interlayers (in the same manner as graphite can be interpolated). By controlling the perovskite sheet thickness, they found that having three or more perovskite layers enhanced a material's optoelectronic performances.

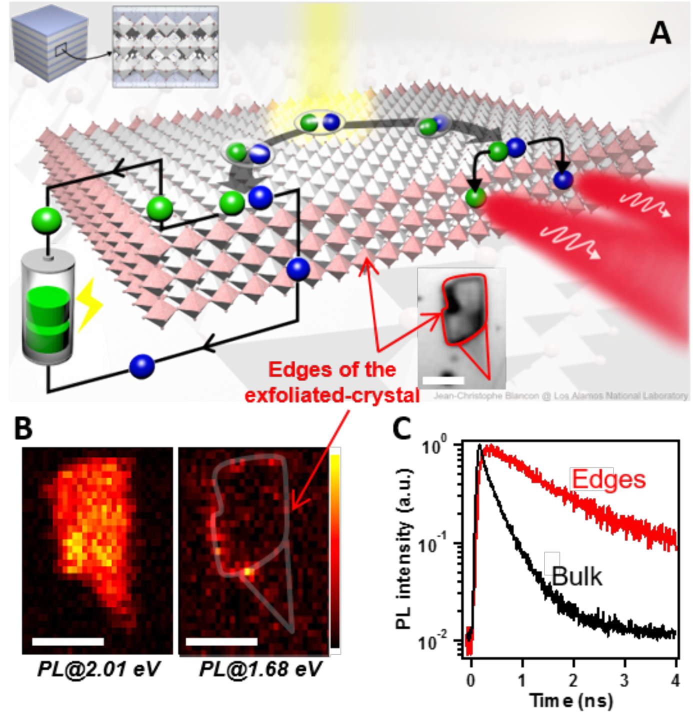
Their strategy was to exploit the unique properties of the states located at the edges of these triple-layered perovskites, which improved photovoltaic efficiencies by 600%. It resulted in greater than 12% improvement efficiency in solar cells, due to the excitons undergoing an unusual and highly efficient process for creating long-lived free carriers.

Their work, published in *Science*, marks the first evidence of an intrinsic mechanism for bound excitons' dissociation in homogenous semiconductors, which is extremely beneficial for light harvesting in photovoltaics and light emission efficiency.

While single- and double-layered perovskite sheets performed as expected, the researchers showed that when the perovskite layers were more than two unit cells thick, photogenerated electron-hole pairs, known as excitons, dissociated and the carriers became trapped at low-energy states near the edge of the crystal layers.

These carriers exhibited a five-fold increase in their lifetime as being protected from energy loss mechanisms. On the flip side, in light-emission applications the trapped carriers recombined efficiently, which resulted in photoluminescence that was about 100 times stronger.

The Los Alamos portion of the work was supported by the Laboratory Directed Research and Development program and partially performed at the Center for Nonlinear Studies and the Center for Integrated Nanotechnologies, a DOE Office of Basic Energy Sciences user facility jointly operated by Los Alamos National Laboratory and Sandia National Laboratories. CINT tools were used to observe flakes and SEM imaging.



(A) Illustration of the dissociation of excitons to free carriers at crystal edges resulting in efficient photovoltaics (>12%) and light emission (>30%). Dissociated carriers captured and located at the edges have lower energy (B) and live longer (C).

The work supports the Lab's Energy Security mission and its Materials for the Future science pillar by tailoring materials to perform in ways beyond their basic properties, thereby enabling controlled functionality, a central vision of the Laboratory's materials strategy.

Researchers: Jean-Christophe Blancon, Wanyi Nie, and Aditya Mohite (Materials Synthesis and Integrated Devices, MPA-11); Sergei Tretiak (Physics and Chemistry of Materials, T-1); Jared J. Crochet (Physical Chemistry and Applied Spectroscopy, C-PCS); Hsinhan Tsai (MPA-11 and Rice University, Houston); P. M. Ajayan (Rice University, Houston); C. C. Stoumpos, M. G. Kanatzidis, and C. M. M. Soe (Northwestern University, Evanston, IL); L. Pedesseau and J. Even (INSA de Rennes, France); C. Katan and M. Kepenekian (Université de Rennes France); and K. Appavoo and M. Y. Sfeir (Brookhaven National Laboratory).

Reference: "Extremely efficient internal exciton dissociation through edge states in layered 2D perovskites," *Science,* **355** (2017).

Technical contact: Aditya Mohite

HeadsUP!

Making room for new electron microscopy equipment

A concerted effort headed by members of the Materials Science and Technology Division led to the successful removal of a more than 20-year-old transmission electron microscope (TEM) from the Electron Microscopy Laboratory in the Materials Science Laboratory (MSL).

Two newer TEMs located in the MSL offer improved resolution and analytical capabilities over the outgoing JEOL 3000F TEM, which was chiefly used for atomic-scale microstructure characterization of materials. Removal activities ramped up with the arrival of an FEI Apreo, a scanning electron microscope that features a compound lens design and compatibility with a broad range of materials. The FEI Apreo will mainly be used for crystallographic and chemical characterization of material microstructures at the nanometer to millimeter scales.

Rodney McCabe (Materials Science in Radiation and Dynamics Extremes, MST-8), Roberta Beal (MST-8), Rafael Spillers (Nuclear Materials Science, MST-16), and Cody Miller (Sigma Division, Sigma-DO) logged several hours facilitating the equipment's removal—detaching equipment, unplugging cables, and removing vacuum components. During the removal process, the Lab's Chief Electrical Safety Officer Lloyd Gordon (Industrial Safety and Hygiene, OSH-ISH) verified that the instrument was in an electrically safe state and that the equipment could not reenergize. Workers, led by Levi Masingale (Logistics Superintendent Field Work Execution, LOG-SUP), did the literal heavy lifting, using a crane to remove large pieces of the microscope. Once safely secured in a truck, the JEOL 3000F was moved to Warehousing and Salvage Operations to be used for spare parts as needed.

Technical contact: Roberta Beal

The JEOL 3000 was removed in three large pieces and several smaller pieces. Above, riggers stabilize the microscope's high tension tank on a dolly. To the left of the riggers is the microscope frame that housed the tank, the TEM column, and other components. Below, the TEM column on a dolly outside the Materials Science Laboratory.

Celebrating service

Congratulations to the following MPA Division employees celebrating recent service anniversaries:

David Langlois, MPA-11 .... 25 years
Fedor Balakirev, MPA-MAG .... 20 years
Jonathan Betts, MPA-CMMS .... 20 years
Michael Gordon, MPA-CMMS .... 20 years
Marcelo Jaime, MPA-MAG .... 20 years
Eric Bauer, MPA-CMMS .... 15 years
John Singleton, MPA-MAG .... 15 years

MPA Materials Matter

Materials Physics and Applications

Published by the Experimental Physical Sciences Directorate

To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 505-606-1822 or adeps-comm@lanl.gov. To read past issues see www.lanl.gov/orgs/mpa/materialsmatter.shtml.

Los Alamos NATIONAL LABORATORY EST.1943

NNSA National Nuclear Security Administration