American Chemical Society AMA: Hi Reddit! I am Prashant V. Kamat, Professor of Chemistry and Biochemistry and the University of Notre Dame. Ask me anything about light energy conversion and more!

AmerChemSocietyAMA [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

Abstract

ACS AMA Hi Reddit, my name is Prashant Kamat, and I am a Rev. John A. Zahm Professor of Science and a principal scientist at the Radiation Laboratory at the University of Notre Dame. My research group focuses on multidisciplinary insight into nanostructure architecture and energy conversion processes, and collaborates with chemists, chemical engineers, and physicists to study the fundamental science and applications of light energy. In addition to my research at Notre Dame, I am also the inaugural Editor-in-Chief of ACS Energy Letters a new journal from the American Chemical Society publishing papers on all aspects of energy research (read the first issue and first of 2017 free). Previously I served as the Deputy Editor for the Journal of Physical Chemistry Letters I am also a fellow of the ACS, the Electrochemical Society, the American Association for the Advancement of Science, and the Indian National Science Academy. I'll be online at 11am ET (8am PT, 4pm UTC) to answer your questions. Go ahead, AMA! - PVK Edit: Signing off now. Thanks for the wonderful discussion. Hope to meet you at the next ACS meeting or another venue.

the WINNOWER

REDDIT

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AMERCHEMSOCIETYAMA R/SCIENCE

ACS AMA

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It's no secret that many of our mobile electronic devices are limited by the capacities of their batteries. Even the promise of solar power is somewhat limited by our ability to store excess energy for use at night. Has battery energy density started to plateau? Are galvanic cells going to be the energy storage device for the foreseeable future or will some other technology supplant it?

shiruken

For mobile phones and other small scale applications we need small and light weight batteries. In some sense we have reached a plateau. Any effort to pack more material to gain higher energy density ends up in disasters. However, we still are in a rising slope in terms of large scale energy density. Nearly two thirds of energy storage is done through 150 year old lead-acid battery technology. Whether it is modern day car or back up power supply, lead-acid batteries dominate. All electric cars and hybrid cars have shown the potential of Li-ion and other storage batteries for large scale applications. Research progress is being made to explore new electrode materials. Redox flow batteries (galvanic cells) are another emerging area that is currently being explored to store energy. Remains to be seen how practical these systems will be in comparison with other storage technologies.

Dr. Kamat, thank you for doing this AMA.

my questions is: from your point of view, considering your extensive knowledge and expertise in the

organic-inorganic perovskite solar cells research. What are the current "known" and "unknown" facts about this exciting material? also, what are the major challenges to implement it commercially, and having it surpass silicon-based solar cells, beside its chemical instability of course?

PS: I've actually met you and trained in your labs for few days, couple of years ago. i'd like to say that i thought you were one of the most confident and knowledgeable scientist I've ever met in this field. thank you for the opportunity.

Chip_N_Charge

First of all thank you for your visit and spending time in our laboratory. There are many intriguing aspect of excited state chemistry especially in mixed halide lead perovskites. Why do they phase seggregate in light and recover in dark? How does halide ion mobilty influence the solar cell performance? How does surface and intrinsic defects influence the excited state deactivation? Controlling surface chemistry will be another major point of study for future. It is difficult to say where the perovskite solar cell will lead to. Even if we overcome the stability issues, will society accept the lead based system? Given the low price of silicon, can perovskite solar cells compete in the market? Perhaps there is a market for specialized applications such as flexible solar cells.

I have 2 parts to my question. What happens when you actually peer review papers?

Also, there are instances of scientists insulting other scientists since their results are different from the known knowledge (say maybe a new discovery), and finding out later on that actually the discovery was major. How can we work to combat this and learn in the 21st century that what is the norm may not actually be right and keep an open mind?

oolala11

The peer review process maintains the scientific integrity within the publication world. The process of gauging the accuracy of results and validity of the claims by the peers has evolved during last few decades. The reviewers provide their input to the editors and it is the editors decision to weigh in the comments and make a final decision. Since it involves human judgement, it is not full proof. The following editorial will provide some insights. Overcoming the Myths of the Review Process and Getting Your Paper Ready for Publication J. Phys. Chem. Lett., 2014, 5 (5) DOI: 10.1021/jz500162r I have not encountered any case of “insult”, but have seen critical discussion. This is a healthy sign to maintain scientific advance. Whenever there is a new phenomenon is discovered, it is put to rigorous test by the peer reviewers. Usually scientists/reviewers like to critique the observations, analysis or claims. Often they demand more explanation. When the authors respond to the reviewers’ concerns the paper becomes scientifically strong.

Hi professor Kamat, I'm a student at ND right now and I'm in the college of science but don't know what to study. Why or why not should I do Chem or biochem if I am enjoying my Chem classes so far?

ogfusername

This is probably the most difficult question to answer for anyone. You need to find out your interest and explore career opportunities and make a decision based on your passion. Please stop by our laboratory. Perhaps you can try summer research to see whether this attracts your interest. We can discuss more if needed.

Hello Professor Kamat, I'm a college freshman doing an independent study on organic photovoltaics -

I'm specifically working with perovskite.

What are your thoughts on the future of organic solar cells? And if you have experience with perovskite, What methods have you found to be effective in raising the efficiency of perovskite solar cells?

Ventus_X_Ventus

Organic solar cells have their own advantage, especially fabricating thin film flexible solar cells. The major development of perovskite solar cells will be seen along with silicon solar cells in a tandem design. It will be a major breakthrough if one can attain efficiencies greater than 26% using tandem design.

Hi Dr. Kamat, I'm a master's student having difficulties in reproducing some of the work on perovskite photovoltaic cells (TiO_2 architecture variant). Do you have any hint or pointers in producing good functional PV cells?

lonewalker

There are few basic techniques that one should follow carefully. Controlling humidity is one such aspect. You may want to refer to a methodology paper published in Chemistry Materials Reproducible Planar Heterojunction Solar Cells Based on One-Step Solution-Processed Methylammonium Lead Halide Perovskites Sai Bai, Nobuya Sakai, Wei Zhang, Zhiping Wang, Jacob T.-W. Wang, Feng Gao, Henry J. Snaith, Chemistry of Materials, 2017, 29,462–473

What do you envision as the long term energy solution for the modern world? A hydrogen economy?

LateCheckIn

Energy derived from hydrogen is clean and one of the highest per mass energy (120.5 kJ/g H2 as opposed to 50.6 kJ/g of methane). It can be cleanly burnt in air or run through fuel cells with water as byproduct. The problem is the current method of hydrogen generation. It is done using fossil fuels. The best source of hydrogen is water (H2O). We can electrolyze water through PV panels or using photocatalyst assemblies. (Imagine a photocatalyst powder that can be spread over a water pond and generate hydrogen by splitting water molecule in sunlight! That's the holy grail in solar fuel generation) Thanks to US Department of Energy for supporting the fundamental research to develop more efficient photocatalyst. Another holy grail of hydrogen economy is the storage and transport of hydrogen. Hopefully hydrogen economy one day can provide us clean energy

Whatever happened to microbial fuel cells? There was a lot of hubbub about it a few years ago after the work done by Bruce Logan at Penn State, but it was never able to be successfully scaled up. Are MFCs still a viable option or are there just too many issues to make scale-up possible?

rseasmith

Microbial fuel cells are attractive to harvest energy from waste water. The overall process is scientifically interesting and may have niche applications in low power generation. The current density one gets is about 1000 times lower than a hydrogen/oxygen fuel cell. Hence they may face difficulty in competing with other practical devices. (Next time you see a current-voltage curve, notice the scale on current axis: It is usually mA/m^2 for microbial cells and mA/cm^2 for fuel cells)

Hi! Thanks for doing an AMA! Sounds like a pretty broad and complicated job! I have a few of questions;

Am I right in understanding that, in basic terms, you look at the ability for various materials of differing chemical make-up to transfer energy under different electromagnetic conditions?

Is this, as some people have suggested, relevant to the solar power industry?

And could you give a short description of a) your personal favourite and b) your highest cited scientific conclusions, along with the practical applications each have?

Thanks!

HerbziKal

Our research is two fold: To advance scientific knowledge of light energy conversion using hybrid light harvesting assemblies. Our major focus is on putting together two or more semiconductor nanomaterials and study the light induced process. Electrons and holes (negative and positive charges) generated in these materials are utilized to generate in solar cells or split water into hydrogen and oxygen. Our research id mainly funded by the federal agencies such as Basic Energy Sciences of the Dept. of Energy. The second goal is to train next generation scientists through PhD and postdoc programs. We have not focused on developing products, but one can imagine several offshoots that can some day find practical applications

Hello Professor Kamat, welcome to Reddit!

Couple of questions:

1. I saw from your group website that your group does research in electrochemistry and batteries and has several papers about using graphene oxide. How does graphene oxide differ from graphite, which is another common anode material, in terms of various battery performance metrics such as energy density, power density and capacity?
2. Could you explain the purpose of ACS Energy Letters and how it differs from JPCL?

Thanks!

edwinksl

Graphite consists of graphene layers. Infact one can easily peel one graphene sheet at a time using scotch tape. Another method to exfoliate graphene sheet is chemical oxidation of graphene sheets. When a few C-C bonds are oxidized the sheets come apart and we call it as graphene oxide. Graphene oxide is inferior compared to graphene in terms of electronic properties. However they can be used as a platform to deposit catalyst particles and increase the loading of the material. J. Phys. Chem. Lett covers all the topics of physical chemistry where as ACS Energy Letters focus on new advances in Energy research. The scope of research publications can be found on the journal home page. Both journals publish new research findings with speed.

Hello Professor! I am a recent physical Chemistry graduate and I plan to attend the upcoming ACS conference in April. Two quick questions,

- What is your opinion on the rising research into hydroxide transfer membranes over proton transfer membranes for electrolytic cells?
- What is the most interesting research paper you have come across while serving as Deputy Editor?

Thank you very much for doing this AMA!

Jromanorum

Both proton and hydroxide membranes are important for the development of fuel cells. These membranes are also useful for photocatalytic hydrogen production (We call it Fuel cell geared in reverse -split water into H2 and O2 using the same cell configuration) Infact bipolar membranes (hydroxide and proton exchange membranes coupled together) are ideal for this purpose. I suggest you to take a look at Editors' choice articles in ACS Energy Letters. Whenever we see a paper with new concept or new phenomenon that can appeal to broader readership, we select them as Editors' choice. These are open access articles -sponsored by ACS Publications.

Dear Professor Kamat Thanks for the time devoted to this session. I have two questions:

1)How can we, young ambitious researchers defeat the bias towards ' pedigree ' from some committees in evaluations /selection processes?

2) I am integrating solar energy harvesting devices in chemical reactions (http://rsc.li/1LJvdQI). What are the main needs and questions from industry regarding the use of solar energy in their processes?

Thank you again for your time! Regards, Alex..

anavarretem

You need to be bold and affirmative in tackling headwind. This is what will make you stronger. Industries adopt processes that are economical. Most of their energy needs are fueled by fossil fuels. Until solar PV becomes cheaper (probably in another 20-25 years) the industries will rely on grid power.

Can you shed some light on the duties of an editor-in-chief of an ACS journal?

What does the scientific advisory board do for the journal?

How does ACS energy letters differ from ACS Catalysis? I'm assuming it will include more photovoltaic work?

NanoChemist

Editor-in-Chief is responsible for overall health and progress of the corresponding journal. At ACS Energy Letters we focus on publishing new scientific advances in the energy research. We seek the feedback of reviewers, editors or EAB members before making an editorial decision. We also seek experts who can write Energy focus and Viewpoints articles so that they can initiate a community based discussion. It is our goal to make this as a premier journal in the field

As a fellow NDer, I was wondering if you had any concern about the future of funding for energy research as our current President seems against the idea of renewable energy. What can we do to protect the funding we find important? Do you imagine there will be a shift to more private donors or crowd-sourcing?

OPsgreatAuntMuriel

I am an optimistic person. I am confident that Congress will continue to support basic research which is

a backbone of our current economic and intellectual progress.

Back in the 80's Arco Solar had a new proprietary process the was to revolutionize solar electric generation. What ever happened to that?

trevisan_fundador

ARCO Solar became the first company to produce more than 1 megawatt of photovoltaic modules in one year. Given the drop in oil prices, they could not sustain. However, new technologies for Silicon and other thin film technologies emerged. Today the prices are dropping very rapidly with its own Moor's law of photovoltaics (check out http://www.bloomberg.com/news/articles/2016-06-13/we-ve-almost-reached-peak-fossil-fuels-for-electricity)

More of a general question, what brought you to, or interested you in, your current research? Additionally, what did the path to your current research topic look like?

Calovichi_Otter

As a child I was fascinated with colors in nature. I started my PhD research working with photochemistry of dyes and semiconductors (1974-1978). I continued my passion to work with such systems and explore new areas of light energy conversion. It is always fun to share my early experiments with students.

What is your favourite wavelength and why?

halborn

My favorite wavelength is 532 nm -green light. Not too high in energy, not too low in energy. Just right. (The eyes are more sensitive to green light also)

Hi Dr. Kamat, I'm studying chemical engineering in university right now. What sort of work do you collaborate on with engineers? Also how do you like your coffee?

StickyBiscuits

The energy research has no disciplinary boundaries. We have students from Chemistry& Biochemistry and Chemical Engineering working in our laboratory. We bring in concepts from Chemistry, Chemical Engineering as well as Physics. We regularly collaborate with the faculty of Chemical Engineering. We have greatly benefited from their expertise in modeling and transport phenomenon. Yes. Caffeine is needed to kick start the day

What advice would you have about current solar technologies for the home? Is it best to wait for more efficient solar panels for the home or are the ones available now worth purchasing?

Loveatfirstype

Silicon solar panels prices have dropped significantly and they are not the major cost of installation. (check out http://www.bloomberg.com/news/articles/2016-06-13/we-ve-almost-reached-peak-fossil-fuels-for-electricity)The major cost now comes from the framework, inverters, labor and utility

regulations etc. (some states charge you a fee if you produce electricity and deliver it to the grid!) The subsidies that were given initially are disappearing as the PV technology becoming competitive. PV installation doubled last year. So, anytime is a good time to install PV. No need to wait.