

Science AMA Series: I'm Saiful Islam, a materials chemist working on lithium and sodium batteries, solid oxide fuel cells and solar cells. I also presented the 2016 Royal Institution Christmas Lectures called 'Supercharged: Fuelling the Future' AMA!

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When you talk about modeling at the atomic level, what does that entail? As in, which phenomena and particles are being modeled? Is it all the way down to protons and neutrons individually, or just a generalized nucleus? If you model the behavior of electrons, do you model probability fields somehow or just create a mathematically similar approximation?

[rslake](#)

Thanks. Two main modelling approaches are used. (1) Force-field or interatomic potentials based which model ion-ion forces using classical terms (electrostatic, short-range repulsive etc); these are useful to look at Li-ion diffusion in large complex battery materials. (2) Electronic structure methods based on density functional theory (DFT) to study electronic band structures, cell voltages etc. [more details on my website: <http://people.bath.ac.uk/msi20/>]

Hello. I was wondering is there one fundamental issue that is slowing the progress of battery technology or is it a series of hurdles that people like yourself work on.

[Dannyboyrobb](#)

Thanks. The latter - a series of hurdles. These include: -materials with higher energy density and faster charge rates -materials that are lower cost, safe and sustainable My research group postdocs/PhD students are investigating these issues and new materials for batteries.

Thanks for being with us today!

Are giant molten salt batteries going to be the future of renewables at the city level?

[PHealthy](#)

Large-scale energy storage will be important for renewables (when the sun isn't shining & the wind isn't blowing). Large batteries may play a part. They need to be low cost and long lifetime. Research groups are looking at molten salt batteries, sodium batteries and redox flow batteries. Not sure at the moment which technology will dominate.

If, like the media suggests, diesel vehicles will no longer be available in a few years time. What do you think is the going to replace it?

[mtron17](#)

I'm afraid I'm not a motoring expert. Due to air pollution and CO2 emissions we should be trying to move towards cleaner forms of transport - which will include more hybrid and electric vehicles. But hard to predict the proportion of types of vehicles on the roads.

Hello Professor Islam, thanks for taking your time to do this AMA! Great fan of your work on solid oxide cells and solid state electrochemistry.

The electrical performance of solid state conducting materials, especially mixed oxygen-ion and electron ceramic conductors, seems to be related to the degradation rate: the high the performance, the higher the degradation rate.

This is related to both the high temperature required to reach required conductivity, but also to the fact that they are in a sense, meta-stable under operation conditions leading to local stoichiometry changes, cross-diffusion issues, corrosion, etc.

Given your experience in the field, and also your more current modelling work, do you think that current research should give way to industrial R&D to design solutions within known limitations, or do you think that a "breakthrough" material with adequate performance/degradation balance is thermodynamically within reach ?

edit: deleted extra word. edit 2: english

[_whatevs_](#)

Thanks for this. There is always a delicate balance between fundamental research on new materials/systems which could lead to a step-change breakthrough in SOFCs and industrial R&D to optimise and commercialise current materials/designs. Both aspects are important for innovation.

I was one of your students once and always loved your lecture style.

My question: how do you write your lectures and deliver them in such an interesting style?

[saeched](#)

Thanks for your kind comments. I always right up lectures by hand and deliver them by writing them on paper for the projector - rather than doing 'death-by-powerpoint'. Also, I recognise that there is a limited attention timespan - so you may recall that I break up the lectures with class exercises or with bad jokes/poetry.

Hello! I'm 18, and starting university next year for materials science. Do you have any advice for a student hoping to pursue a career in the sciences? What kind of obstacles may I face?

[Jetstream13](#)

Good to hear about your university degree in materials science. It's a wide field, but follow the topic you're passionate about - but don't forget to put in the hard work as well as having fun. To follow a career in sciences, most (but not all) go on to do a PhD. Hopefully you won't face any major obstacles. Good luck.

I really enjoyed the Xmas Lectures, thanks for doing this too. If you had to look ahead to the next 50 years what do you think will be the next 'big thing' in energy generation or storage?

[ajd65](#)

Thanks for this. Predicting 50 years ahead is always difficult. One thing is certain about the future - it's uncertain! I'd like to see is a much greater proportion of world energy generation and storage from sustainable low carbon technologies. So 'big things' would be rechargeable batteries with much higher energy densities and solar panels with much higher efficiencies and lower cost.

How likely will large scale sodium/sulfur based batteries be used to store the excess solar energy for release overnight? Also, can these types of batteries be used to capture electricity from lightning strikes?

Publication: [large scale sodium/sulfur batteries](#)

[boiler725](#)

Yes, sodium/sulfur based batteries are being investigated for potential large scale energy storage. But I'm not sure if this technology will dominate. Research groups are also looking at molten salt batteries and redox flow batteries. I'm afraid I don't think these types of battery can be used for lightning due to the massive surge in electrical charge.

How soon would you say until we have phone batteries that stay charged for 24+ hours under normal modern use? It seems that battery technology (particularly in homes) hasn't really progressed in the past 5-10 years to an extent that would be noticeable by the everyday person.

[JungleLoveOreOreo](#)

Thanks. As mentioned in Lecture 3, getting Li batteries in modern mobile phones to stay charged for longer is a big challenge - largely because the phone electronics have become more power hungry and are really mini-supercomputers with apps, wifi, camera, torch etc. Current Li batteries would allow older mobile phones (only 5-8 years old) to last on one charge much longer than 24hrs. There's a lot of research looking at batteries that have much higher energy storage - including our group.

Hi Saiful,

Thanks for doing this today.

Are you concerned about the potential effects on UK science of leaving the European Union?

[septic_bob](#)

Uncertainties related to the position of EU researchers working within UK groups and to the

interactions/collaborations within EU research networks are a concern. I'm naturally an optimist and hopeful that the worst fears will not be realised.

Hi, First off, I would like to say that your Christmas Lectures were really enjoyable and interesting! It was a great way to celebrate the anniversary of the RI Christmas Lectures!

Secondly, how do you get the ideas for the lectures and form them into a lecture? What kind of things make a lecture interesting?

[theintendomusicnerd](#)

I'm glad you enjoyed the Ri xmas lectures. The Ri decided that the theme this anniversary year would be 'energy' - partly due to the links with Michael Faraday - the founder of the xmas lectures. Most of the ideas came from what we know about energy and electricity and from my own research on materials for clean energy.

As a fellow computational materials scientist, I appreciate the 'I model' response - I like to tell people I'm a lingerie model when they ask for specifics.

My question is what role do you see glassy electrolytes playing in battery development, as opposed to crystalline?

[thiney49](#)

Glassy electrolytes are not in my area of expertise - but could play a role in solid-type batteries if their ionic conductivities and stability are high enough and much better than crystalline materials.

Are there established routines to evaluate lithium diffusion in non-stoichiometric materials and alloys? Say, I am designing a $\text{Ge}_{0.25}\text{Si}_{0.75}$ alloy (with some B doping, etc) as an anode material, and I am not a computational chemist. How can I estimate its lithium diffusion coefficient?

[svavil](#)

I haven't done the expts, but I believe there are diffusion measurements using GITT or NMR techniques. But this needs checking. Computer modelling uses molecular dynamics techniques to estimate Li-ion diffusion coefficients - which have been largely successful for oxide cathode materials.

I was a massive fan of the RI Christmas Lectures when I was growing up, haven't seen them in probably 15 years but I'm glad they are still going. I will see if I can find a moment to watch at least a bit of yours.

What a wonderful honour to be invited, I used to work on science documentaries and I'm curious how much work went in to these lectures from yourself. How much of the planning/designing of the lectures was down to you and how much was done by the production team from the BBC? More importantly, did you enjoy the experience and would you do it again?

[Robo-Connery](#)

Yes, a huge honour to be asked to present the 2016 Ri xmas lectures (following the likes of Attenborough, Sagan & Dawkins). It was a challenging and all-consuming experience from about October onwards. Together with the producer, Tom Cook, the ideas and scripts were put together first

and then demo ideas were included. Overall, I did enjoy the experience (with stressful moments) with a great/fun team around me. I hope find time to watch them on BBC iplayer - there's a world record in lecture 3!

Do you miss being in the lab or are you happy "not wearing a lab coat" most days? And how did you get into computer modeling? Was it something offered at your graduate program or did you have to figure it out yourself?

[firedrops](#)

Thanks for this. Yes, I'm happy my research is computer modelling and not wearing a lab coat! In the final year of my BSc Chemistry degree at University College London I got involved in a research project using computer simulation codes and enjoyed it. I decided to stay on to do PhD in the area of computer modelling of oxide semiconductors and high Tc superconductors.

Thank you for doing this today, my question is perhaps a little different.

As a young resident of Bath myself, how would you recommend getting into a similar field of science? What advice would you give based on your own success?

Thanks a ton!

[t_pugh](#)

If you're a GCSE student and enjoying studying science - stick with it at A-level. At Uni open days I always say: follow the subject that you're passionate about - but don't forget to put in the hard work (just like top athletes). I studied Chemistry at degree level and carried on to do a PhD in the energy materials area. Hope that helps.

I have a question related to EVs. What do you think is a reasonable time or distance range we can expect an electric vehicle to reach in, say, the next 5 years? Are you partnering up with companies in the automobile industry to make the shift towards electric vehicles happen even faster?

[J4CKR4BB1TSL1MS](#)

This relates to 'range anxiety' with EVs. I think the current max range for an EV (Tesla) is about 300 miles. I suppose a target in the next 5 years is for most EV models to reach that and pass it. Interestingly, about 80% of car journeys in Europe are less than 40 miles anyway. So EVs would be good for city/urban driving. I'm part of a consortium of university research groups (called Supergen) which has links with a few battery pack and car manufacturers.