

American Chemical Society AMA: I am Robin D. Rogers, Professor of Green Chemistry at McGill University. Ask me anything about sustainable chemistry and crystal engineering!

AmerChemSocietyAMA ¹ and r/Science AMAs¹

¹Affiliation not available

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As a chemistry undergrad who recently began thinking about pursuing a career in sustainability, what is the best way to enter the industry? I'm particularly interested in finding new, or more efficient, ways to recycle [rare/overused elements](#).

While I do have quite a few student loans to repay, money is not an issue. To be honest, I care more about contributing something to society than anything material. And I feel like this is one of the few fields I can combine my love for chemistry (especially in the laboratory) and my humanitarian drive.

As a secondary question, what are some good resources to educate myself on sustainability efforts? I'm sure there are all kinds of fascinating research projects out there beyond the scope of recycling, but I wouldn't even know where to begin (in my entire undergrad I have only heard one professor even mention it--the very dialogue that caught my interest).

[Chambana_Raptor](#)

Great question! Here you will first have to ask yourself if you want to work for a traditional industry or whether you want to start your own company and become entrepreneurial. I honestly see great opportunities for entrepreneurs who bring ethical capitalism to the table. Another way of saying this is doing you want to go work for Kodak to make better photographic film (oops too late!) or do you want to build a company around digital photography?

I consider it a mindset. Many students I work with today want to make a difference as you do and sometimes there is no traditional route to do so. In my view not every chemical company around the world is on board with green chemistry yet, so yes you may need to find your own way.

One great place to start is with the American Chemical Society Green Chemistry Institute (<https://www.acs.org/content/acs/en/greenchemistry.html>). You can also check out the efforts at the University of Oregon (<http://greenchem.uoregon.edu/>).

I suggest you become active and push for the changes you think are needed. You see this around the World today, so why not in Chemistry as well?

RDR

Hello Dr. Rogers,

Much synthetic chemistry depends on solvents, reagents, and moieties with environmental and health risks better understood now than in the past. However, in my anecdotal experience practices have only changed when dictated by immediate financial imperatives (eg. Added costs of waste disposal) and opportunities to make money off a promising compound appear capable of overriding prudence in some cases. Often new compounds are introduced to the marketplace without disclosure to the consumer buying the product or any other public scrutiny. Examples of these are halogenated organics in the food supply as well as the lack of disclosure in plasticizers, fragrances, and drilling fluids in the oil and gas industry.

Do you see hope for change in mainstream chemistry to become more green? Do you think change is likely to come from academia, regulatory or public pressure? Will less harmful practices have to wait until they are economically superior to conventional processes? Is there a role for science educators in redirecting public distrust of "chemicals" towards specific risks? Is there any hope for greening a way of life that's still too cheap to phase out lead acid batteries?

[PM_ME_CAT_GIFS](#)

I have my own philosophy here and it involves personal responsibility. I am a chemist and I believe it is my job to make life better. I have chosen to do this in a way that would help Society become sustainable. Am I disappointed in the pace of change? Yes. Do I believe change is impossible? No. However, right now it is hard as any new alternative technology we need must not be environmentally damaging, must be societally acceptable, and (yes this is a big one) must make money. So when you now start factoring in environmental integrity with social and economic justice, with making money, it's a new ballgame. And oh by the way, you must compete at the same price point as oil based chemicals and plastics.

Not a winning combination... unless, you are inventive.

I believe real change will be a partnership of Society and its governments and researchers.

For a sample on my philosophy about renewable plastics and chemicals check out Rogers, R. D. "Eliminating the Need for Chemistry," Chemical & Engineering News, December 7/14, 2015, pp 42-43 (<http://cen.acs.org/articles/93/i48/Eliminating-Need-Chemistry.html>).

RDR

What is crystal engineering?

[MethSC](#)

I admire engineers for their ability to design, build, and operate plants at virtually any scale. Imagine if you had the knowledge and the tools to design any crystalline material at any scale with any form and with any functionality. Crystal Engineering studies the interactions between molecules (the tools) and uses this knowledge to design and build crystalline materials for very specific jobs. RDR

Do you receive much support from Government entities? It seems many governments - my own Australian one included - don't seem as focused as they should on renewable *anything*, and are withdrawing a lot of funding and grant money for a lot of renewable and 'future-focused' research. Do projects like yours struggle for funding, or are you well looked-after?

[PinchieMcPinch](#)

I think you are asking a lot of governments to legislate their economies into bankruptcy (which is how they see it). Imagine if tomorrow the World's governments said, not one more drop of oil will ever be used. I imagine a bit of societal and economic collapse since until you need the alternatives it seems no one wants to pay for them.

Did you see this from France? http://mashable.com/2016/09/17/france-plastic-cups-ban/?utm_cid=mash-com-Tw-main-link#S7RESg6GJGqk

Quite a challenge, but now imagine they had said instead "No more synthetic plastics may be used ever."

Our job is to help governments and Society navigate to the solutions and open the discussion with new ways of thinking.

RDR

What are some industries or technologies that probably need your green revolution to happen and why? Meaning, where is the low hanging fruit that absolutely requires our attention?

[Cognitive Ecologist](#)

The one we hear about today in a growing Societal voice would be plastics derived from oil. Of course, it's one of the hardest to replace because of how cheap plastics are and how far we have come in our ability to find inventive uses for them. The low hanging fruit I am going after will be very high value polymers such as chitin (or its derivative chitosan) in medical devices. We use an Ionic Liquid process to extract chitin directly from shrimp shells. If we can get a high value polymer it will more than cover the cost of the extraction. However, this same extraction can also pull biopolymers out of trees, grasses, hair, etc. Applications of those need our process to be cheaper, so as we make it better and cheaper for specialty polymers from Nature, we will reach a price point where all of a sudden the other polymers and uses will become more financially attractive.

RDR

in your opinion, what type of battery is going to be powering our homes and cars in the next 15 years?

[freshoutofgravitas](#)

Sorry, I can't give you the answer here. It is not always the best technology which wins. In my era Betamax video cassette magnetic tape was the best technology, but VHS format won the day in the US.

Now of course how many people even know what I am talking about?

Instead of going for the best battery, as a researcher, I would go for the best source of power to run my devices. I intend that to be a natural polymer textile embed with the capacity to directly turn sunlight into powered my devices.

RDR

What is your experience with sustainable polymers?

[th2darkm1nd](#)

What we are really working hard on these days, is the combination of being able to sustainably extract cellulose, chitin, and other natural polymers directly from their biomass source and to be able to sue them directly, without derivatization in making advanced functional materials. Its quite exciting these days!

RDR

What's your favourite restaurant near McGill ?

[andrew_asf](#)

Cafe Fanelli. I eat there for lunch when I can. If you go say Hello to Frankie!

Do you think it will ever be efficient/viable to use cellulosic ethanol as an alternate fuel source?

[tommy285](#)

I am going to answer this one with a comment I use in my talks and perhaps you will understand my philosophy.

In Alabama (where I grew up), we have known how to make ethanol for corn for a long long time. However, we do not burn it in our cars, we drink it!

Really though, the question I always ask is why take Nature's beautiful polymers and then degrade them into monomers or small molecule chemicals at all? Why not use them as polymers?

Given that you're from Alabama and now work in Canada, where do you see the future of international research in the field going, especially outside of academia? As a non-scientist reading about work such as yours, it can be frustrating to feel like there are an almost insurmountable number of barriers to understanding technical work that is published in journals. Would part of the mandate of the companies you've founded be to provide outreach to the general public, both off and on the Internet? How will you go about this, and which part of your research do you think will ultimately be most relevant to our everyday future lives?

[kerimontreal](#)

Outreach and education are vital to sustainability. I do take it as a personal responsibility to be involved in these. Our job is to make sure our work is understandable and no, we do not always succeed.

I travel the world and understand that we are not all the same in terms of our cultures, our priorities, or even our needs. I believe in Global knowledge sharing, but local solutions to many problems. I am working with collaborators on 6 continents to try and bring sustainable technologies to fruition.

Just by watching TV, you can understand navigating governments and policies can be quite tricky and each is different. That is why I believe the solutions to problems of sustainability will be local. What works in the US may not work in China.

What I feel has been lost through the years in my field (Chemistry) is public trust. You are right in that we must build this by being able to explain what we do in a way which is truthful and understandable. I will keep trying!

RDR

Hi Dr. Rogers,

What do you know about mining waste valorisation? I read recently about Geopolymerisation which made crystal out of rocks containing silicium and aluminium.

Do you know other promising new technology in that field ?

Thank you for your time !

[mariebrutale](#)

It can certainly be done, but I would rather eliminate mining if possible. We have one research project to 'mine' uranium from the oceans. If we could get all of our metal needs by simply pulling them out of the ocean, perhaps we could eliminate terrestrial mining and the waste. Environmental problems that go with them. Of course here come those economic problems again. Land mining is cheap....

RDR

Hi Dr. Rogers, I've seen a number of questions on career prospects in green chemistry but none on crystal growth. As someone with a master's thesis in hydrothermal crystal growth, what are the career prospects for crystal growing - they seem few and far between?

[phill_davis](#)

Yea! Finally, a crystal growth question! Crystal growth is a major component in several high tech industries. One that comes to mind is the pharmaceutical industry, where controlling the size, shape, and polymorph of an active pharmaceutical ingredient.

Crystal Growth is also important in the electronics industry, LEDs, lasers, etc. I happened on this, <http://web.info.uvt.ro/~braescu/courses/Crystals%20and%20Crystal%20Growth%20-%20introductory%20survey.pdf>, while answer your question.

To plug my own journal, I would also suggest you scan the pages of the ACS' Crystal Growth & Design (<http://pubs.acs.org/toc/cgdefu/current>).

RDR

As a high school teacher, what areas could I recommend to students thinking of careers in chemistry as fields of future growth to give them the best chances of success?

[Liberal_irony](#)

I believe there will be a materials revolution where we will need to be innovative in the use of our natural resources to make the 'things' we use today. Unless we dramatically change perceptions of 'quality of life', consumption will rise. Your students could likely have full careers working in any chemical industry at the current Societal rate of change, but I would encourage them to think differently and challenge the status quo. Chemist are needed in the energy, water, materials, even food sectors. We especially need people with vision to see beyond what we know today into what we will need in the future.

I admit that our current educational structure in Chemistry is not exactly set up for that today, but I do

see it changing. I challenge my students at McGill for example, to help tackle the problems we see. Gold mining still uses sodium cyanide. Why? No one has come up with a better alternative that they can afford to use.

So, I see the next big careers in Chemistry to come for the innovators and entrepreneurs. I like this quote from Georg Washington Carver: "Since new developments are the products of a creative mind, we must therefore stimulate and encourage that type of mind in every way possible."

RDR

Hey! I'm interested in the field of Green Chemistry, but currently my university doesn't have any specific programs. How can I learn more about it?

[Spontida](#)

One great place to start is with the American Chemical Society Green Chemistry Institute (<https://www.acs.org/content/acs/en/greenchemistry.html>). You can also check out the efforts at the University of Oregon (<http://greenchem.uoregon.edu/>).

RDR

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No. Our goal is to prevent this. Of course we will need everyone else's help.

RDR

I'm a medicinal chemistry undergrad, who is currently taking a physical chemistry lab. In an upcoming lab we will attempt co-crystal engineering. If we successfully make new crystals, we have the opportunity to possibly get published. My question to you is what are some resources I can start looking at to come in prepared and get some new crystals? Also do you have any recommendations as to any particular chemicals I should try? We can order almost any chemicals we want to try. Thanks

[DevinAngevine](#)

We have a lot of this research published in Crystal Growth & Design (<http://pubs.acs.org/action/doSearch?AllField=co-crystals&type=within&publication=40025988>). Of particular importance today would be crystals of pharmaceutical to make them more soluble. Since many of these you are likely not to have access to, you might start with things like caffeine, artificial sweeteners, etc. Also check out the web site of my Associate Editors Mie Zaworotko (http://www.ul.ie/crystalengineering/michael_zaworotko) and Adam Matzger (<http://umich.edu/~ajmgroup/>).