Interview

Making sense of complexity

Rustem Ismagilov talks about all things microfluidic...and economics to Neil Withers

Rustem Ismagilov

Rustem Ismagilov was born in 1973 in Ufa, Russia. After graduating from the Russian Academy of Sciences in 1994 (Moscow), he received a Ph.D. with Stephen F. Nelsen in physical organic chemistry from the University of Wisconsin–Madison in 1998. His postdoctoral work was with George M. Whitesides at Harvard University. He began his independent career in 2001 as an Assistant Professor at the University of Chicago, Department of Chemistry, where he is now an Associate Professor. He is a member of the *Lab on a Chip* editorial board.

Why do you work with microfluidic devices?
I am very interested in complex networks, especially chemical networks, and to study them experimentally it's very hard to use an Erlenmeyer flask – you really need a lot more things than a flask provides. You need to be able to control space and time, and to be able to continually supply reagents and remove products. Microfluidic devices are an ideal medium for studying them.

Can you tell us more about these complex networks?
One example that we work on is the network of blood clotting or coagulation, where you get about 80 reactions coupled together. It's complex because you can know everything about each reaction, but you still don't understand how blood clotting works: you really need to look at the whole thing. We've done a number of experiments where we've looked at the initiation and propagation of clotting in microfluidic devices, which allowed us to control where reactions were initiated and where they go.

Tell us about your recent work where you performed over a thousand protein crystallisations in half an hour.
Another area where microfludics might be really useful is miniaturising and speeding up doing multiple experiments on a chip. That work is based on our droplet microfluidics work on reaction networks, but it turned out to be useful for protein crystallisations. We generated droplets a few nanolitres in size that contained the protein and other additives. Then we watched to see which droplets give the crystallites. My students worked out very clever ways of generating and keeping track of droplets that don't involve a lot of human intervention: that was the big breakthrough. And that particular paper is important to us because it allows us to look at membrane proteins, which are the most difficult ones to crystallise and only available in small quantities.

What's the secret to your success?
Well, if I knew what the secret was I'd do more with it! There isn't much to our secret, we try to do new things and try to come up with new ideas – then we get lucky sometimes. Sometimes we don't. More seriously, working on new things or trying to come up with new ideas that people haven't really worked on is something that distinguishes what we do from what a lot of other people, starting out, do. It's more risky because if you do something new, you don't know if it's going to work out, but in our case we got lucky and the risk paid off.

Is there any microfluidic devices can't do?
The biggest limit is finding a really important application that the scientific community in general will embrace. There are some, for example DNA separation, that are being commercialised and making an impact, but coming up with something so important that no-one can live without it will be the next breakthrough. Pretty much anything can be done, but because of that breadth, people haven't found the one thing that's really going to make the future.

What's hot at the moment in your field?
There's a lot of effort in biology in general, because that's where the impact of miniaturisation can be felt very strongly, but to me personally there are a lot of opportunities in beginning to understand complexity. We are getting unprecedented tools that allow us to control chemistry and biology on many time and length scales to get experimental systems that we could never have dreamt about 20 years ago.

What's the trickiest problem that you've faced?
Building a research group! Maybe that's not quite answering the question, but the trickiest problem is really putting it all together: you can't just get funding or just come up with a good idea. You also need really good students and to educate them and provide them with enough freedom so that they can explore their own things, but still stay on course and get somewhere. Those are the kind of things that when I was starting out I didn't appreciate how important they were – or how much time they would take.

If you weren't a scientist, what would you do?
I'd probably try to become a scientist of some sort! I'm also very interested in learning about economics, trying to understand how those dynamic systems work. In many ways they're very similar to chemical networks and there are the same issues of global behaviour: the behaviour of individual pieces and how they come together.