Youth Views on Sustainability

Size Matters, But So Does Speed

by Jonathan de Roo

I'm a man. I like speed! I drive my car fast. I hate waiting but I always pick the wrong queue in the supermarket. Same thing applies to my research. I'm a chemist and I have to do chemical reactions but can't stand slow reactions.

So What Can We Do About It?

Before we answer the question, you need to understand that there is not much of a difference between chemistry and cooking. In both cases, you search for a recipe or you craft one yourself. The recipe tells you which ingredients are required. For my chemical reaction, you need hafnium chloride and benzyl alcohol.

According to the recipe, you need to mix these and heat them up in an oven at 220 °C. And then ... wait ... three days. Three long days.

So what can we do about it? Think! At home, if you want to heat food really fast, you don't use the ordinary oven (so passé), you use the microwave. So why not microwave my reaction to speed it up? Well, that's a bad idea, as chemical reactions in the microwave happen to explode once in a while. That's why today many chemical labs are buying a specialized, explosion-free microwave (€ 30 000). This is what

such a device looks like:

It is somewhat expensive but when I put the reaction in this microwave, it was completely finished in just three hours. The graph puts this into perspective with the 72 hours needed in an ordinary oven. This is a huge difference, justifying the investment.

If we transfer this microwave concept to the chemical industry, this could lead to an enormous reduction in time, money, energy input, and CO₂ emissions.

Good for me, industry, and the environment!

So What's the Secret?

For that, remember the first time you put a frozen lasagna in a normal oven? After a while you saw a tasty crust and you thought "ok, it's done." You took it out, put your fork in it, and it was still stone cold in

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This online platform also covers major international scientific discussions, such as the Young Observers World Leadership Meeting 2013, during the IUPAC General Assembly, in Istanbul. IUPAC also wants to support and highlight the views of younger generations on sustainability matters, and will be featuring some blog posts from the YourFormula community in upcoming issues of *Chemistry International Magazine*.

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the middle... That's because an oven provides heat from the outside, which means the middle is cold unless you wait a very long time; see the picture with the temperature profiles.

This makes it possible to form such a delicious crust, but chemically speaking a crust is just burnt food. However, we don't want our chemicals to burn. Unlike the oven, the microwave heats from the inside out. So it's hot in the middle but not on the edges. That's why the microwave heats much faster. In addition, no crust is formed in the microwave, so we don't burn chemicals, only producing what we desire. Now, what did I make in the microwave? Hafnium oxide nanoparticles. Here is a picture of them.

As I told in previous posts (please check www.yourformula.eu), nanoparticles can be used in various applications. In particular, the hafnium oxide nanoparticles were distributed in superconductors to improve

the quality of the latter. Now what is a superconductor again? Imagine yourself running through a crowded street. That's normal conductivity. Now imagine running through the same street, at night, without anyone in your way. That's superconductivity. A superconductor can transport electricity without any resistance, so without energy losses.

Just like a baker puts raisins in bread to improve the flavor, chemists put particles in materials to improve the properties. The result can be a higher material strength or a better conductivity, etc. With the nanoparticles these superconductors can carry more current so that we can use them in applications. There are medical applications like MRI scanners and there are green applications where superconductors save a lot of energy or even better; harvest energy. With superconductors we can construct more powerful wind mills, leading the way to a more sustainable future.

In conclusion, just remember there is essentially no difference between a cook and a chemist, and both can accelerate their reactions with a microwave! If you want to learn more on this subject, please see my TEDx talk. You can find it on my blog post at www.yourformula.eu. 🎤

References

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Jonathan de Roo is a PhD student at Ghent University, Belgium. He is working on a project which unites the "Sol-gel Centre for Research on Inorganic Powders and Thin films Synthesis" (SCRiPTS) and the Physics and Chemistry of Nanostructures Group (PCN) of the University of Ghent Department of Inorganic Chemistry. The focus of his PhD is the synthesis of various oxide nanoparticles that can be used for photocatalytic

hydrogen production and to enhance the properties of superconductors. He believes that research in this field can provide new energy sources and new ways of energy storage, hence paving the road to a sustainable future.

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