

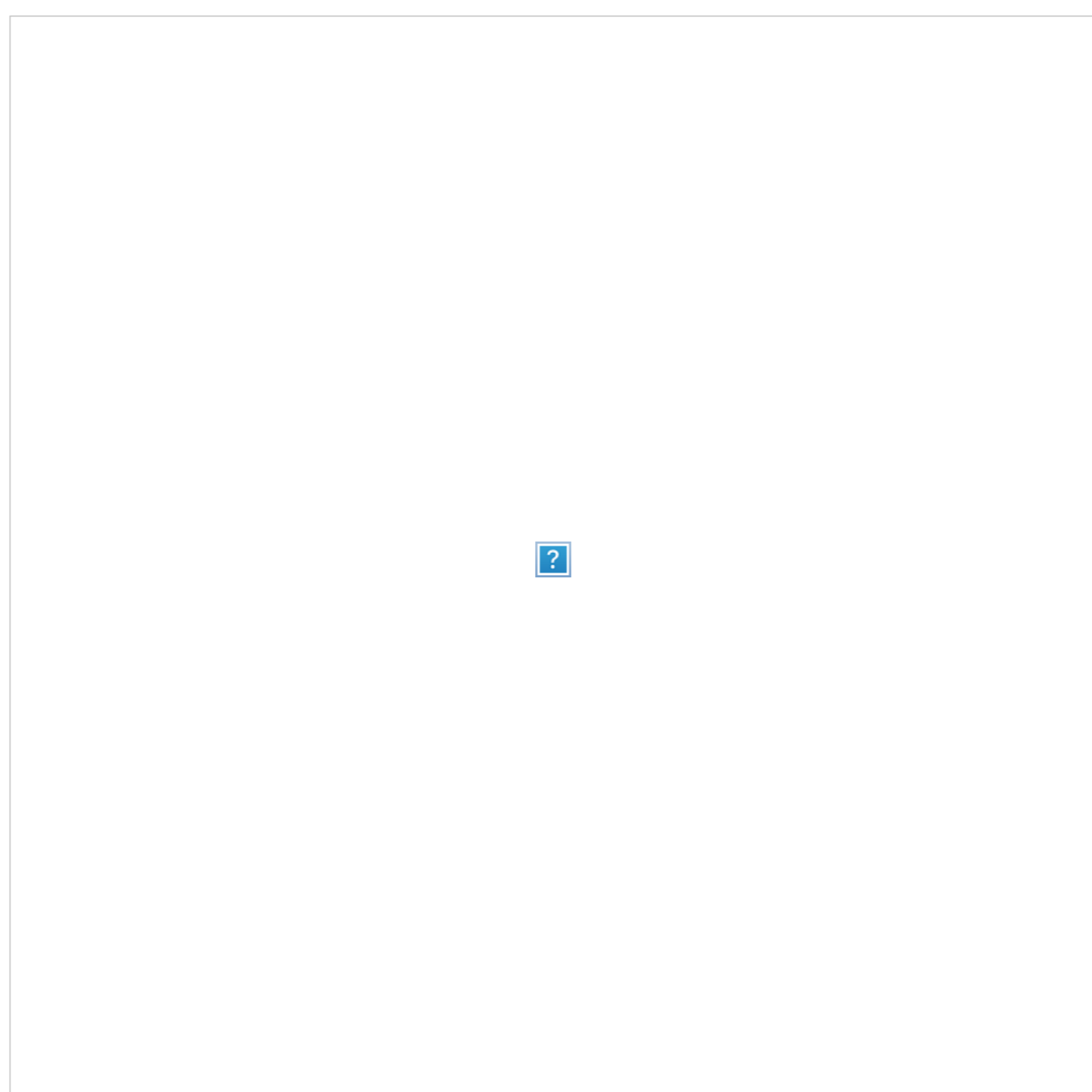
RESEARCH

High-Strength Organic Materials Can Be Made Quickly & In Eco-Friendly Way Using Hot Water Vapor

By [James Ayre](#) Published March 24, 2014 f t i e 1 Comment

A fast and eco-friendly new means of synthesizing high-strength organic materials has been developed by researchers at the Vienna University of Technology.

Interestingly, the new approach relies on high heat and high pressure for the synthesis — conditions that had been thought to be incompatible with the production of organic materials. These harsh conditions, though, allow for the creation of these materials without the use of hazardous solvents (as is typically necessary) — instead, all that is needed is hot water vapor.



"Microflowers" made of PPPI, the world's most mechanically stable organic polymer. The blossoms are approximately five microns wide. Image Credit: Vienna University of Technology, TU Vienna

Many of the materials that can be produced via the new approach are in quite high demand — for instance, Kevlar — and used for a number of different common purposes, such as in lightweight construction, protective clothing, and/or sports equipment. This new approach could lead to the sourcing of these materials becoming considerably "greener" and/or cheaper.

The Vienna University of Technology provides more:

It seems counterintuitive: one might expect large, complex organic molecules to be destroyed by heat and high pressure. But at 200 degrees Celsius and 17 bars, Miriam Unterlass and her team at TU Vienna have synthesized organic polymers, which are usually extremely hard to create and require highly toxic additives. Instead of hazardous solvents, the team at TU Vienna uses nothing but harmless water vapour, making the new method extremely eco-friendly.

The principle of so-called "hydrothermal synthesis" is well known from geology. Many gemstones only form deep down in the ground, in high-pressure water reservoirs. In contrast to these inorganic minerals, which are often mainly made up of silicon and metal ions, many high-performance materials are organic. They primarily consist of carbon and hydrogen.

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Kevlar is an example of such a high-performance polymer. It is extraordinarily robust and it is used for protective clothing or for construction elements that are supposed to withstand extreme strain. Such materials also play an important role in aircraft construction, because they are much lighter than any metal parts with comparable properties. Organic high-performance polymers are huge organic molecules with a very stiff structure, kept in place by a multitude of bonds between the atoms.

But these durable materials are, as you might guess, quite difficult to synthesize. Miriam Unterlass explains: "We have to deal with two contradictory requirements. On the one hand, we want to have rigid materials which do not dissolve and do not melt even at high temperatures. On the other hand, this means that we cannot just dissolve and then crystallize them, as we would if we were dealing with simple rock salt, for example."

So, in the new process, the polymers are instead forming and crystallizing simultaneously — supported by hydrothermal conditions.

As stated before, there are a number of distinct advantages to this all — there are no dangerous byproducts created, energy consumption is cut considerably, and the process is much faster than with any other approaches.

Also, the end-result is a better product: "Our method yields materials with higher crystallinity, which further improves the mechanical rigidity," states Miriam Unterlass.

There is, as nearly always with these sorts of things, still in need of some fine-tuning before the approach can be commercially applied.

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In this article: organic material production, TU Vienna, Vienna University of Technology, Waste Reduction

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James Ayre

James Ayre's background is predominantly in geopolitics and history, but he has an obsessive interest in pretty much everything. After an early life spent in the Imperial Free City of Dortmund, James followed the river Ruhr to Coblenz, where he attended the University of Astriede. And where he also briefly considered entering the coal mining business. He currently writes for a living, on a broad variety of subjects, ranging from science, to politics, to military history, to renewable energy.

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