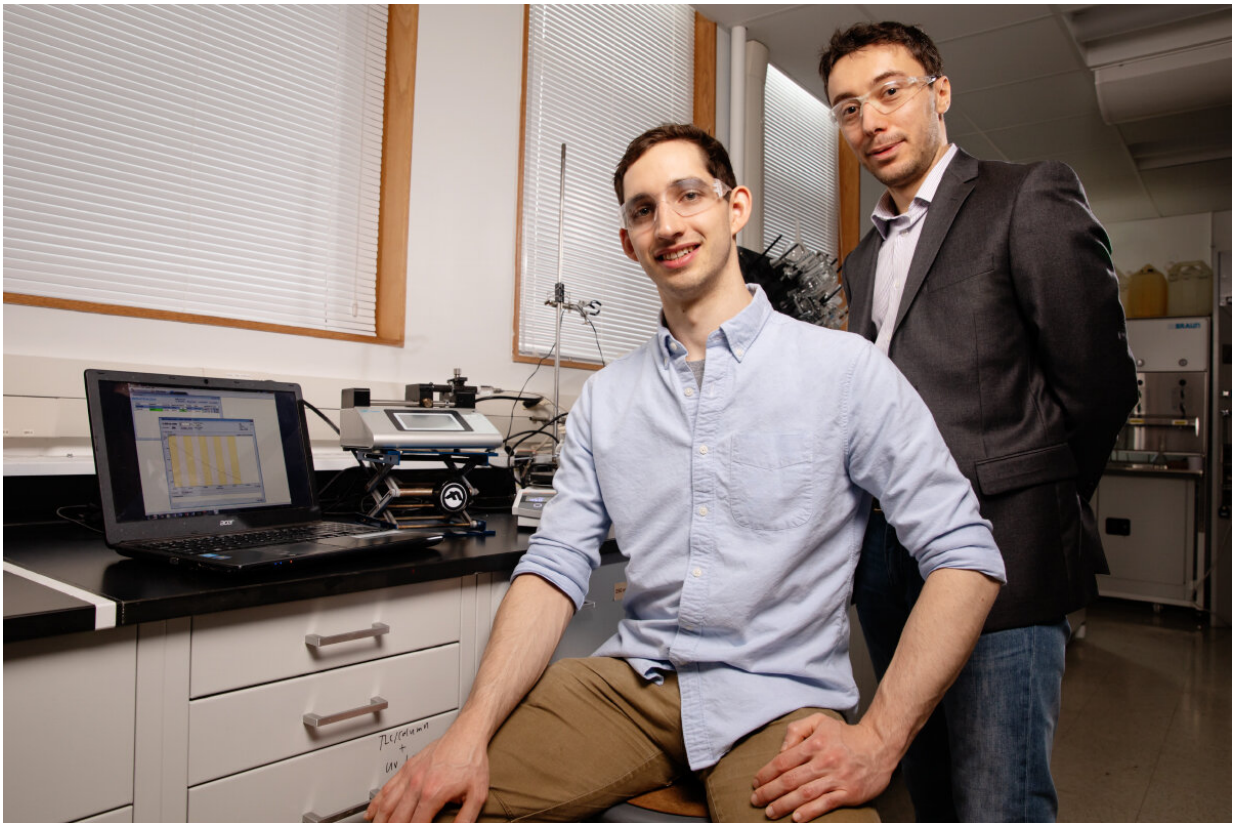


Researchers gain control over soft-molecule synthesis

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Chemical and biomolecular engineering professor Damien Guironnet, right, and graduate student Dylan Walsh developed a new technique that allows them to program the size, shape and composition of soft materials. Credit: L. Brian Stauffer

By gaining control over shape, size and composition during synthetic

molecule assembly, researchers can begin to probe how these factors influence the function of soft materials. Finding these answers could help advance virology, drug delivery development and the creation of new materials.

"We approached this new research concept not by trying to fix a problem, but by asking what is possible when it comes to soft-molecule synthesis," said Damien Guironnet, a chemical and biomolecular engineering professor at the University of Illinois at Urbana-Champaign and lead author of a new study. "What if we can gain control over things like shape, size and composition during molecular synthesis—what does that mean?"

The findings are reported in the *Proceedings of the National Academy of Science*.

For years, scientists have struggled to clarify how nanoparticle shape and size influence their behavior within living tissue, the researchers said. "The size of the synthetic molecules we are creating correspond to the size of viruses," said Dylan Walsh, a chemical and biomolecular engineering graduate student and study co-author. "Observations made from controlling these factors will allow researchers to probe these types of questions."

The team combined classic chemical synthesis techniques and basic chemical engineering principles. They introduced [precise control](#) over the polymer formation sequence via the [flow rate](#) of the building blocks used. By altering flow rate, the new process can yield soft matter with unique architectures, the researchers said.

"We use mathematical modeling to predict the shape, size and composition of molecules we create and use computer-guided synthesis in the lab to adjust the flow rate of the mixtures that control the

architecture of the polymer," Guironnet said.

The researchers felt it was not enough to simply state that they can do this—they needed to prove it.

"Our mathematical modeling does not include any assumptions so there is really nothing else that can be formed other than what we model, but math is not something you can see," Guironnet said. "Shape is something we can see, and we were able to verify with microscopic imaging that we formed polymers consistent with what we predicted."

The team achieved this with synthetic molecules that are soluble in [organic solvents](#), but the next step will be to move onto water-soluble [molecules](#). "If we truly want to better understand our [immune response](#) and improve drug-delivery specificity, we need these to be water-soluble so that they can work in our bodies," Guironnet said.

The researchers view this work as a big step forward in advancement of soft-material synthetic polymer science.

"We have access to new building blocks, and now we can work on figuring out how we can use these blocks to assemble new materials at the molecular level," Walsh said. "We think of it as playing with Legos to see how the [shape](#) of the individual building blocks influences the final product."

More information: Dylan J. Walsh et al., "Macromolecules with programmable shape, size, and chemistry," *PNAS* (2018).
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