Scientists find new way to manipulate DNA

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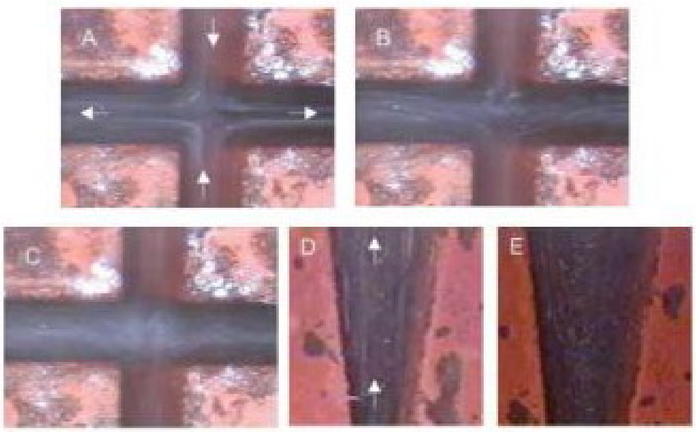

Image of flow. Credit: Generated by University of Michgian, reused with permission from the Proceeding of the National Academy of Sciences

Polymers, large molecules comprised of chains of repeating structures, are used in everything from the coatings on walls of ships and pipes to reduce flow drag to gene therapy.

But long polymer chains are subject to breakage, called scission, and a new study by the University of Michigan shows that as it turns out, much of what scientists previously thought about why polymers break when subjected to strong flows, such as waves crashing against a ship's bow, was wrong.

This is important for a few reasons, said Michael Solomon, associate professor in the Department of Chemical Engineering, Macromolecular

Science and Engineering Program. Broken polymers don't function as intended, and if scientists don't know what causes them to break, they can't keep them from breaking, nor can they design them to break in specific places.

For the past 40 years, scientists have not understood exactly which forces caused scission, said Solomon, who is the co-author on a paper published last week in the *Proceedings of the National Academy of Sciences*. The paper, "Universal scaling for polymer chain scission in turbulence," defines which flow forces and at what levels those forces cause polymers to break in turbulence.

"This paper understands how they are breaking in a new way that resolves some issues that have been present for 40 years," Solomon said.

The experiments that yielded the prevailing scission theories, Solomon said, did not take into account turbulence in the flow that occurred during the experiments, and how that turbulence attributed to polymers breaking. Those experiments measured only laminar or smooth flow, which is turbulent free.

Yet, during their own experiments, the U-M team discovered that flow turbulence did indeed exist and that it was impacting the polymer quite a bit. Through experiments that accounted for turbulent flow, Solomon and co-authors Steven Ceccio, with appointments in the Department of Mechanical Engineering and Naval Architecture and Marine Engineering, and then-doctoral student Siva Vanapalli, were able to develop and test formulas for different polymers, and pinpoint exactly how they would react to different flows. Vanapalli is now a post-doctoral fellow at Twente University in the Netherlands.

The equation they developed can be applied to design flows that break polymers into certain lengths, or to design polymers to withstand certain flows. This could have big implications for industries that rely on polymer coatings, such as shipping or oil.

"When the polymers are working their best the friction can be reduced by 70 percent," Ceccio said.

The research also has implications in the field of gene therapy, allowing scientists another tool to control the length of the strands of DNA. In genome sequencing, the first step is to take the genome and break it into small pieces to reassemble it into the DNA strand that is best for further biochemistry, Solomon said.

Source: University of Michigan

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