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Turning injectable medicines into inhalable treatments with the help of smart phone components

Imagine if all childhood vaccines could get delivered with an inhaler rather than shots; or wiping away tuberculosis bacteria in a patient's lungs with an inhaler; or disinfecting a hospital room thoroughly with a diffuser.

James Friend, a professor of mechanical and aerospace engineering, has received a prestigious research grant from the Keck Foundation.

These are the goals of a research team led by Professor James Friend in the Department of Mechanical and Aerospace Engineering at the University of California San Diego. Their efforts were recently boosted when Friend received a prestigious $900,000 research grant from the Keck Foundation, whose mission is to support pioneering discoveries in science, engineering and medical research.

"Our goal is to make injectable treatments inhalable," Friend said. "This would unlock a whole class of new treatments."

For example, in a clinical setting, powerful disinfectants could be delivered via diffusers in hospital rooms to eliminate harmful bacteria. A whole new class of medicines could be delivered to patients via inhalers. Finally, a whole range of new materials could be used for 3D printing.

Currently, fluids can be nebulized in many different ways, for example by mechanical means like in perfume and cologne sprayers, or by using ultrasound. But all of these methods either don't work well with very viscous fluids like oil or honey, or they require too much power, or

break down some of the fluids' active ingredients. They also require expensive equipment.

The method developed by Friend and colleagues uses devices found in smart phones that produce acoustic waves. In the phones, these devices are used mainly to filter the wireless cellular signal and identify and filter voice and data information.

In the lab, Friend and his team used the devices to generate sound waves at extremely high frequencies—ranging from 100 million to 10 billion Hertz — in order to create fluid capillary waves, which in turn emit droplets, generating mist. This process is called atomization. The researchers' breakthroughs are based on the ability to atomize liquids that have been considered too viscous for the process before.

The new method holds the promise of dramatically lowering costs for developing inhaled drugs by using smart phone components that are inexpensive. Currently, the cost for developing inhaled medicines is $300 million over a period of three years.

Researchers successfully tested the atomization method on a powerful disinfectant, Triethylene glycol, or TEG, which had never been atomized before on its own (it is usually dissolved in water).

No one before had observed how fluids behaved when subjected to such high sound frequencies. Scientists led by Friend discovered that the equations used to predict wave generation in fluids did not work for their experiments—in fact, they are off by several orders of magnitude. Some of that math dates back more than 150 years, to experiments by British physicist and chemist Michael Faraday.

The Keck grant will allow researchers to acquire the cutting-edge technologies as well as the workforce they need to figure out the right math to describe and predict atomization at such high frequencies. This in turn will allow researchers to apply their new method to a broader range of materials, unlocking new applications.

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