Roland Piquepaille's Technology Trends
How new technologies are modifying our way of life

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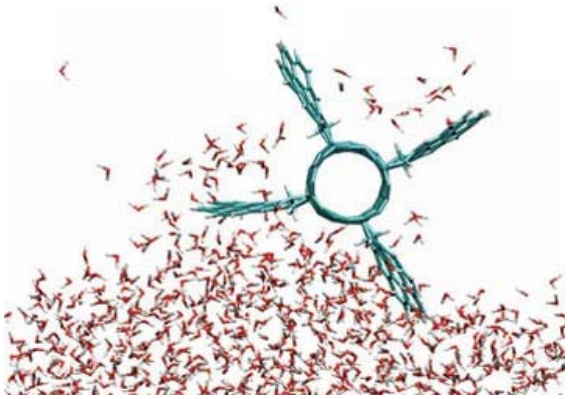
Nano propellers for drug deliveries

Researchers at the University of Illinois at Chicago (UIC) have used molecular dynamics simulations to build a nanoscale propeller with molecule-sized blades. This is the first time that researchers are looking at nanodevices able to pump fluids. However, they recognize that such devices will not be available before several years. If these nano propellers ever come on the market, they would be used for applications such as precisely targeting medicines and regulating flow into and out of cells.



You can see above "a water propeller made from a rotating carbon nanotube, with blades of hydrophobic aromatic molecules." (Credit: Petr Král's team, UIV, via *Physical Review Letters*).

These nano propellers have been simulated by Petr Král, Assistant Professor in Physical Chemistry and his research group.

As I wrote above, "while previous research has looked at how molecular devices rotate in flowing gases, Král and his group are the first to look at molecular propeller pumping of liquids, notably water and oils." "We want to see what happens when the propellers get to the scale where it's impossible to reduce the size of the blades any more," said Král.

The group also was surprised by the results of some simulations. "At the molecular level -- unlike at the macro level -- the chemistry of the propeller's blades and their sensitivity to water play a big role in determining whether

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the propeller pumps efficiently or just spins with little effect. If the blades have a hydrophobic, or water-repelling nature, they pump a lot of water. But if they are hydrophilic -- water-attracting -- they become clogged with water molecules and pump poorly." "Pumping rates and efficiencies in the hydrophilic and hydrophobic forms can differ by an order of magnitude, which was not expected," he said.

So what can we expect from this research? "Král added that such technology probably won't become reality for several years, given the difficult nature of constructing such ultra-small devices." "The 21st century will be about hybrid biological and artificial nanoscale systems and their mutual co-evolution," Král predicts. "My group alone is working on about a half-dozen such projects. I'm optimistic about such nanoscale developments."

For more information, this research work has been published in *Physical Review Letters* under the name "Chemically Tunable Nanoscale Propellers of Liquids" (Volume 98, Number 26, Article 266102, June 28, 2007). Here is a link to the abstract and its contents. "We explore the limits of liquid pumping by “classical propellers” with molecular-scale blades. Our molecular dynamics simulations reveal a huge sensitivity of pumping to the chemistry of the blade-liquid interface. We demonstrate selective pumping of hydrophobic and hydrophilic liquids, where the pumping rate is determined by the effective profile of the solvated nanoscopic blades."

The illustration above also was the cover image of this *Physical Review Letters* issue.

Sources: University of Illinois at Chicago news release, July 16, 2007; and various websites

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