The ultimate molecular chess match

September 26 2013, by Angela Herring

For the last two decades, it's been said that carbon nanotubes hold the promise to transform a range of fields, from alternative energy to drug delivery. But making that happen has proved difficult, according to Hicham Fenniri, an international leader in nanotechnology and new professor in Northeastern's College of Engineering.

"Carbon nanotubes are fascinating materials," said Fenniri, who also serves as a Director of the Biomedical Engineering Research Center in Doha, Qatar. "They have amazing chemical and physical properties, but they are challenging from a synthetic point of view." Controlling their size, purity, and electrical properties, he explained, are just a few of the challenges standing in the way of realizing the material's high-value added applications.

In the early 90s, Fenniri decided to take matters into his own hands. "I was thinking, how can we develop a material from the ground up so we can control all these properties," he said. Since then, his work has led to the development of the world's first self-assembling organic nanotube, a signature accomplishment that established him as one of the field's leading innovators.

In contrast to carbon nanotubes, Fenniri's truly organic tubes consist not only of carbon but also other elements that make up all living things—oxygen, hydrogen, nitrogen, and many others. The tubes are biocompatible, making them a prime material to use as a coating for a medical implant or as a vehicle for drug delivery. Fenniri is also using them as components in novel electronic and photonic devices.

Historically, a conductive organic supramolecular nanowire has been an elusive target. But in recent years, Fenniri and his colleagues have been hard at work attempting to use their nanotubes as carriers for electrons, just as conductive metal wires do;. Their preliminary reports have confirmed the feasibility of their innovative strategy. The potential achievement, he said, could transform the alternative energy sector. He is also exploring potential medical applications for his materials, including whether they would make effective antibacterial agents.

"With organic chemistry, you can construct essentially any molecule by a combination of reactions and processes," Fenniri explained. "Really, you can liken it to a chess game: you can look at the target molecules and design a strategy to get there."

This is exactly the approach his team is taking in the development of new applications for their self-assembling nanotubes, which comprise smaller chemical components that have been adapted to fit their particular needs. Fenniri compared the synthetic approach to a set of Lego bricks—instead of different colors you have different chemistries. With this arsenal of building blocks and the natural tendency of molecules to obey certain organizational laws, he's winning a host of molecular chess games.

Provided by Northeastern University