Chemists develop technique to use light to predict molecular crystal structures

March 23 2011

A Syracuse University chemist has developed a way to use very low frequency light waves to study the weak forces (London dispersion forces) that hold molecules together in a crystal. This fundamental research could be applied to solve critical problems in drug research, manufacturing and quality control.

The research by Timothy Korter, associate professor of chemistry in SU's College of Arts and Sciences, was the cover article of the March 14 issue of *Physical Chemistry Chemical Physics*. The journal, published by the Royal Society of Chemistry, is one of the most prestigious in the field. A National Science Foundation Early Career Development (CAREER) Award funds Korter's research.

"When developing a drug, it is important that we uncover all of the possible ways the molecules can pack together to form a crystal," Korter says. "Changes in the crystal structure can change the way the drug is absorbed and accessed by the body."

One industry example is that of a drug distributed in the form of a gel capsule that crystallized into a solid when left on the shelf for an extended period of time, Korter explains. The medication inside the capsule changed to a form that could not dissolve in the human body, rendering it useless. The drug was removed from shelves. This example shows that it is not always possible for drug companies to identify all the variations of a drug's crystal structure through traditional experimentation, which is time consuming and expensive.

"The question is," Korter says, "can we leverage a better understanding of London and other weak intermolecular forces to predict these changes in crystal structure?"

Korter's lab is one of only a handful of university-based research labs in the world exploring the potential of THz radiation for chemical and pharmaceutical applications. THz light waves exist in the region between infrared radiation and microwaves and offer the unique advantages of being non-harmful to people and able to safely pass through many kinds of materials. THz can also be used to identify the chemical signatures of a wide range of substances. Korter has used THz to identify the chemical of signatures of molecules ranging from improvised explosives and drug components to the building blocks of DNA.

Korter's new research combines THz experiments with new computational models that accurately account for the effects of the London dispersion forces to predict crystal structures of various substances. London forces are one of several types of intermolecular forces that cause molecules to stick together and form solids. Environmental changes (temperature, humidity, light) impact the forces in ways that can cause the crystal structure to change. Korter's research team compares the computer models with the THz experiments and uses the results to refine and improve the theoretical models.

"We have demonstrated how to use THz to directly visualize these chemical interactions," Korter says. "The ultimate goal is to use these THz signatures to develop theoretical models that take into account the role of these weak forces to predict the crystal structures of pharmaceuticals before they are identified through experimentation."

Provided by Syracuse University