

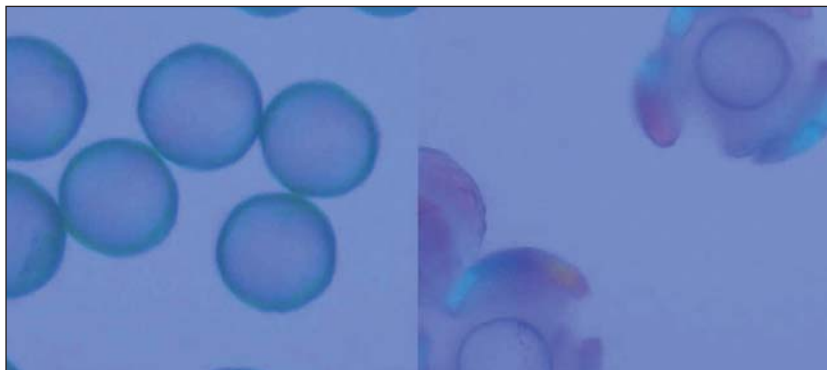
Drug Delivery Systems Get Smart

Peaks and valleys — that's an all-too-common dosage problem encountered by patients who must take a daily regimen of medications. Today's drug delivery systems face the challenge of dealing with these highs and lows. "There is definitely a question of safety when it comes to this issue," says Nicholas Peppas, a professor of engineering in the departments of chemical and biomedical engineering at the Univ. of Texas at Austin (UT Austin). If the dosage is too high, the medication can become toxic; too low, and there is no effect.

Furthermore, patients do not always follow the doctor's orders, so there is a concern about patients' compliance. Take, for instance, diabetics who need to regularly monitor their blood-sugar levels and then administer a specific amount of insulin according to the test results. A person may forget about taking the medication, or in extreme cases, may get frustrated with the constant monitoring and daily injections and just decide to skip it altogether. Now, imagine if that problem was solved.

Mimetic Solutions LLC (www.mimeticsolutions.com), an Emergent Technologies Fund IV portfolio company, is taking on the task of solving this problem. At the helm of the company are Peppas, who will remain on the faculty of UT Austin and serve as the co-chief scientist, along with Dr. Zach Hilt, who is currently on the faculty at the Univ. of Kentucky.

At the heart of Mimetic Solutions' technology is its proprietary Affinimer chemistry, which allows for the development of chemically engineered smart polymers that can bind to specific "trigger" molecules, such as a key biomarker in a patient's blood or skin, and subsequently release a drug or other agent under pre-programmed conditions (photo). For instance, "cardiac failure is related to high cholesterol and other certain microproteins," says Peppas. "If you



Mimetic Solutions' smart polymer, or "Affinimer," is programmed to rupture upon binding to a target analyte. Shown above is a fluorescent micrograph of particles with an Affinimer layer (left), and rupture and release of their internal contents (right). The technology was invented by Dr. Nicholas Peppas, Dr. Zach Hilt and Dr. Mark Byrne, who serve on the faculty at UT Austin, Univ. of Kentucky and Auburn Univ., respectively.

have an Affinimer that can recognize cholesterol, then it becomes active and releases the required dosage," he continues. When the biomarker is not detected, the system remains idle.

In the works

While the development of an Affinimer that recognizes cholesterol is still a work in progress, Mimetic Solutions is currently focusing on two primary delivery systems — TheraSmart and BeautySmart. TheraSmart involves the production of single- or multi-pulse capsules that, on cue, release a therapeutic payload. Multiple formulations are possible within a single capsule, enabling pulsatile or coordinated drug release from a single dosage. Rather than requiring that a drug be taken several times a day, a single pill can release the drug each time its corresponding biomarker reaches a threshold level in the bloodstream. Furthermore, multiple trigger chemistries can be engineered into the formulation, allowing for a coordinated, multi-analyte-triggered release of two related drugs.

The BeautySmart system uses capsules and films for triggered release of fragrance, essential oils, vitamins or anti-aging compounds. The system can be engineered to respond to specific body cues and actuate re-

lease of the desired compound.

One of the first applications Mimetic Solutions is working on is the smart release of insulin in response to blood glucose levels in diabetic patients. Dubbed GlucoSmart, this therapy is designed to automatically respond to glucose levels without the need for self-testing or self-dosing.

So far, "we have completed the proof of concept on the Affinimer chemistry," says Brian Windsor, managing director of Mimetic Solutions. "We are now in discussion with several pharmaceutical and personal care companies, and the feedback from these potential partners has been positive," he notes. "For products that do not require FDA approval, it is quite possible to see a product on the market within a year," he concludes.

The future of drug delivery is changing. "Fifty years from now, capsules will be obsolete," says Peppas. Instead, he envisions a device that will be embedded in our bodies that will detect biomarkers, send the information to our brain and start therapeutic treatment — all without us having to lift a finger.

Dr. Nicholas Peppas is the 2007 Institute Lecturer at the AIChE Annual Meeting in Salt Lake City, UT (Nov. 4-9, 2007). His discussion will be on "Le plus ça change... Nanotechnology and Bioengineering in an Evolving Chemical Engineering World."