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Startup Spotlight: Poway grads think big while using world's thinnest material

Mark Armao/The Daily Transcript
Brett Goldsmith, co-founder and chief technology officer of Nanomedical Diagnostics, pipettes a sample onto a graphene-coated microchip attached to the company~s flagship device, the AGILE R100.

By Mark Armao

Every time you drag the tip of a No. 2 pencil across a sheet of paper, thin flakes of graphite sluff off the solid core, leaving a trail of carbon atoms stacked hundreds of atomic layers high.

Isolate an atom-thick layer of carbon, and you have produced graphene — the thinnest material known to man.

Often cited as being 200 times stronger than steel and 40 percent more electrically conductive than copper, graphene has been shown to have some remarkable properties, garnering considerable interest from the science community, the public and companies hoping to cash in on its revolutionary potential.

But, many graphene experts caution that attention-grabbing headlines — such as those that claim a sheet of graphene could support the weight of an elephant — are misleading.

"You could breathe on it and it falls apart," said Ross Bundy, CEO of Nanomedical Diagnostics, a San Diego-based startup that created a bioelectronic device that operates using graphene.

Bundy co-founded the company with CTO Brett Goldsmith in 2013. The pair of Poway High School graduates wanted to figure out a way to leverage graphene's unique properties for commercial applications.

Lifting a pachyderm was not among their aspirations.

Goldsmith, who studied physics at UC San Diego, had just co-authored an academic paper demonstrating that a graphene-based biosensor could be used to detect a protein associated with Lyme disease.

Because existing diagnostic tests for Lyme measure a patient's antibody response to the infection, and not the infection itself, the results of the study attracted significant interest from the medical community.

The findings also prompted the San Diego natives to start their company. A graduate of the EvoNexus incubator, Nanomed has raised roughly $3.7 million through a Series A financing round and multiple bridge rounds.

Their first product, the AGILE R100 bioassay device, enables researchers to directly detect molecules with no lower size limit using a gadget the size of a TV remote.

Goldsmith said the R100 has myriad potential applications, but will initially be used as a drug discovery platform — measuring how well a candidate medication binds to a disease target.

The company's early customers include academic and research organizations, including the Scripps Research Institute and the Stanford University School of Medicine, as well as several pharmaceutical and life sciences companies in various stages of evaluation and procurement.

Although the team hopes the product will eventually be used as a diagnostic tool — in a medical lab or even a bedside setting — the AGILE device has been marketed as a research tool, partly because of the regulatory and financial hurdles involved in bringing a medical device to market.

"You're not guaranteed that a particular amount of money will get you through the FDA, so it's helpful as a small startup company to have an income stream that is separate from the regulated market," Goldsmith said.

Whether the risk-averse medical community will adopt the technology is also difficult to predict.

"Going through the life science market to begin with is a good way for us to build that validation," Bundy said. "We have customers publishing papers on using the technology, [which] helps the clinical pathologists be a little more comfortable with the technology."

Allowing lab workers to become acquainted with the tool will be an essential step, as no other device on the market uses an electronic, graphene-based sensor to characterize biomolecules.

"We're used to having our biology in one world and our electronic devices in another world," Bundy said. "What graphene is uniquely able to do is to actually bridge those two together — and that's what we do."

In Nanomed's 5,000-square-foot office and lab space in Sorrento Valley, members of the 14-person company perform the research, quality assurance and even some of the manufacturing required in the development of the R100.

Building on decades of nanotechnology research — and countless hours of their own trial-and-error — the team developed techniques to "grow" graphene in a specially designed work cell. They then apply the graphene to six-inch-diameter silicon wafers that are subdivided into the 200 tiny squares that will become the biosensor chips.

"We have about 250 little tricks that we had to figure out to make all this work and to be able to do this at scale, but now we're at about a 90 to 95 percent chip yield for each wafer that we make," Bundy said.

To operate the system, a researcher simply inserts one of the disposable chips into the R100 and plugs the device into a laptop using a standard USB cord. The user can then begin testing samples by pipetting liquid solutions directly onto the biosensor.

Similar tools for biophysical assays can cost upwards of $300,000 and require extensive training, Bundy said. The AGILE R100 costs $20,000, and requires almost no expertise to operate.

"We've sent it to people with no training, and they've plugged it into their computer and used it," Bundy said.

If, for example, a group of researchers wanted to make a drug that blocks a protein associated with heart disease, they would compile a list of target compounds to test against the protein, or capture molecule.

The researchers would then pipette a liquid solution containing the target molecules onto the graphene chip, before running an electric current through both the solution and the chip.

The capture molecule, which is attached to the graphene, acts as a barrier between the two fields. When a target molecule binds with the capture molecule, the interaction alters the properties of the current running through the graphene.

By measuring and analyzing those changes, the researchers can determine whether a drug candidate had the desired effect on the protein.

The Nanomed team is currently developing a second model, the R200, which will be capable of analyzing far more samples at once.

The new model will be fitted with a 96-well plate, a standard tool in pharmaceutical research and clinical diagnostic laboratories. Each of the small test tubes will have a graphene biosensor chip at its base, allowing for a throughput nearly 100 times greater than the R100.

If Nanomed secures its Series B financing in the near future, Bundy said the company will likely hire at least 10 people by the end of the year. The company also plans on expanding its sales — which have thus far been focused on the San Diego and San Francisco Bay areas — nationwide.

And, while the homegrown entrepreneurs are committed to advancing their product development efforts and refining their graphene-production techniques, they take solace in the fact they are, to their knowledge, the only company that has ever commercialized a graphene-based biosensor.

"There are people who have used graphene to augment existing products — light bulbs and tennis rackets — but we're the first company that's using graphene as an enabling component for a new type of product," Goldsmith said. "It's very interesting having conversations with people at bigger companies who have tried to do this and failed. Those are fun conversations for me."

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