

Ideas on the Edge

Diagnosis on the Dot

QUANTUM DOTS ARE REALLY, REALLY SMALL.

BUT UNIVERSITY OF TORONTO SCIENTIST ULLI KRULL IS SHOWING HOW THEY'LL MAKE A REALLY BIG DIFFERENCE IN DIAGNOSIS.

They're unimaginably tiny, oddly behaved—and incredibly versatile. “Quantum dots” are artificial assemblages of atoms that are revolutionizing fields as diverse as biology, medicine, computing and power generation.

Depending on its structure, a quantum dot can be as small as 20 atoms across, or about 2 billionths of a meter. “You're getting down to molecular dimensions in size,” explains Dr. Ulli Krull of the University of Toronto at Mississauga. “And when you do that you get some interesting properties that you don't see at the level of the everyday world.”

One of those properties involves the way quantum dots respond to light. In the world of our everyday experience, the colour of light that objects reflect or emit is based on what they're made of. But at scales involving billionths of a metre, we enter the unintuitive realm of quantum effects. When you shine a light on a quantum dot, the colour of light that comes back is determined by the dot's size. And since the size can be precisely set during



Ulli Krull holds a beaker containing models of quantum dots, the nano-particles that are a focus of research at the Centre for Advanced Biosciences and Biotechnology.

fabrication, dots can be “tuned” to emit a specific colour when excited by light.


This combination of diminutive size and “tunability” has made these particles very useful as optical “biosensors”—beacons that light up to indicate the presence of even the tiniest amounts of a particular substance—a virus, for example, or a marker for a type of cancer. Scientists accomplish this magic by wrapping a quantum dot with a layer designed to bond chemically with the target substance, and by adding a biological switch that disables the light-emitting capability of the dot unless this bonding has taken place. Once the target substance bonds to the particle, however, the modified dot glows with a distinctive colour when it's exposed to light.

These biosensors could, in theory, be released in quantity into the body to find and then illuminate their quarry. But it's difficult to read the light of the

beacons accurately through layers of tissue and fluid.

Dr. Krull is also looking at a solution to this problem.

At UTM's Centre for Applied Biosciences and Biotechnology— a facility funded partially through an investment by the Ontario Innovation Trust—he's



developing a way to attach the nanoscale sensor particles to the outer surface of a fibre optic probe. The probe can be inserted into a sample—and perhaps one day, into a human body. Light pumped into the fibre will cause the beacon dots to glow if the target substance is present, and the same fibre carries their tell-tale colour back to the observer.

By covering the probes with a variety of sensor particles designed to detect different substances, they could be very versatile tools for diagnosing a range of illnesses at their earliest stages. Two other big advantages: the results would be available in minutes, and the probes would be reusable. Neither is the case with current

RESEARCH THAT MATTERS
REAL-WORLD BENEFITS FOR ONTARIANS:

- fast, early diagnosis of illness
- detection and prevention of environmental pollution
- improvement of the reliability and quality of water and food

methods of lab testing. The technology has many other applications as well, including testing for pathogens in food and water, and for environmental pollution.

While it will be a few years before these kinds of probes are in daily use, Dr. Krull can see them on the horizon—and he's excited.

"There are all these things going on at the molecular level, and as we learn to harness them, we're going to

CABB: Very advanced. Very applied.

The range of advanced research at the Centre for Applied Biosciences and Biotechnology is astonishing.

Ask Ulli Krull, the principal investigator at CABB, for a list of highlights, and he hardly knows where to begin. Researchers at the Mississauga facility are looking at an amazing range of subjects, from biosensors to the development of designer polymers to an exploration of the frontier that links psychology and genetics.

"The faculty represent a variety of fields, including physics, chemistry, psychology and a number of other areas," he says. "The intention was to provide the infrastructure so that this group could work together and really explore what could be done in a cross-disciplinary setting."

But as advanced as the research is, Dr. Krull is particularly proud of how the Centre is applying its expertise in partnership with the surrounding community. "What we've done is taken the resources of the CABB facility and made them available as the research arm of the City of Mississauga. We work with the city on the development and delivery of its practices, in terms of anything that has to do with health and the environment."

The partnership between the city and the university has been so successful that the World Health Organization has dubbed it the "Mississauga Model" and is touting it as an example for cities and institutions everywhere.

see some very exciting technical and chemical advances.

"That's what turns me on. We're at the stage now of being about to harness those properties."

Project: Centre for Applied Biosciences and Biotechnology
Institution: University of Toronto at Mississauga
Research Discipline: Health Sciences/Diseases
Principal Investigator: Ulrich Krull
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CFI Investment: \$2,358,983
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MaRS Centre, Heritage Building
101 College Street, Suite HL20
Toronto, ON M5G 1L7
416-977-9188 Fax: 416-977-9460
innovation@oit.on.ca
www.oit.on.ca

Infrastructure for Innovation About the Ontario Innovation Trust

The Ontario Innovation Trust was created in 1999 by the Government of Ontario to invest in research equipment and facilities at Ontario's universities, colleges, hospitals and other non-profit research institutions. The Trust is governed by a volunteer Board of Directors, according to the terms of a Trust agreement established by the Ontario government. A small permanent staff looks after day-to-day operations.

Since its inception, the Trust has committed almost \$843 million to strengthen Ontario's position in the global marketplace of ideas. This represents more than a third of the \$2.44 billion in total funding that has been invested in Trust-supported projects.