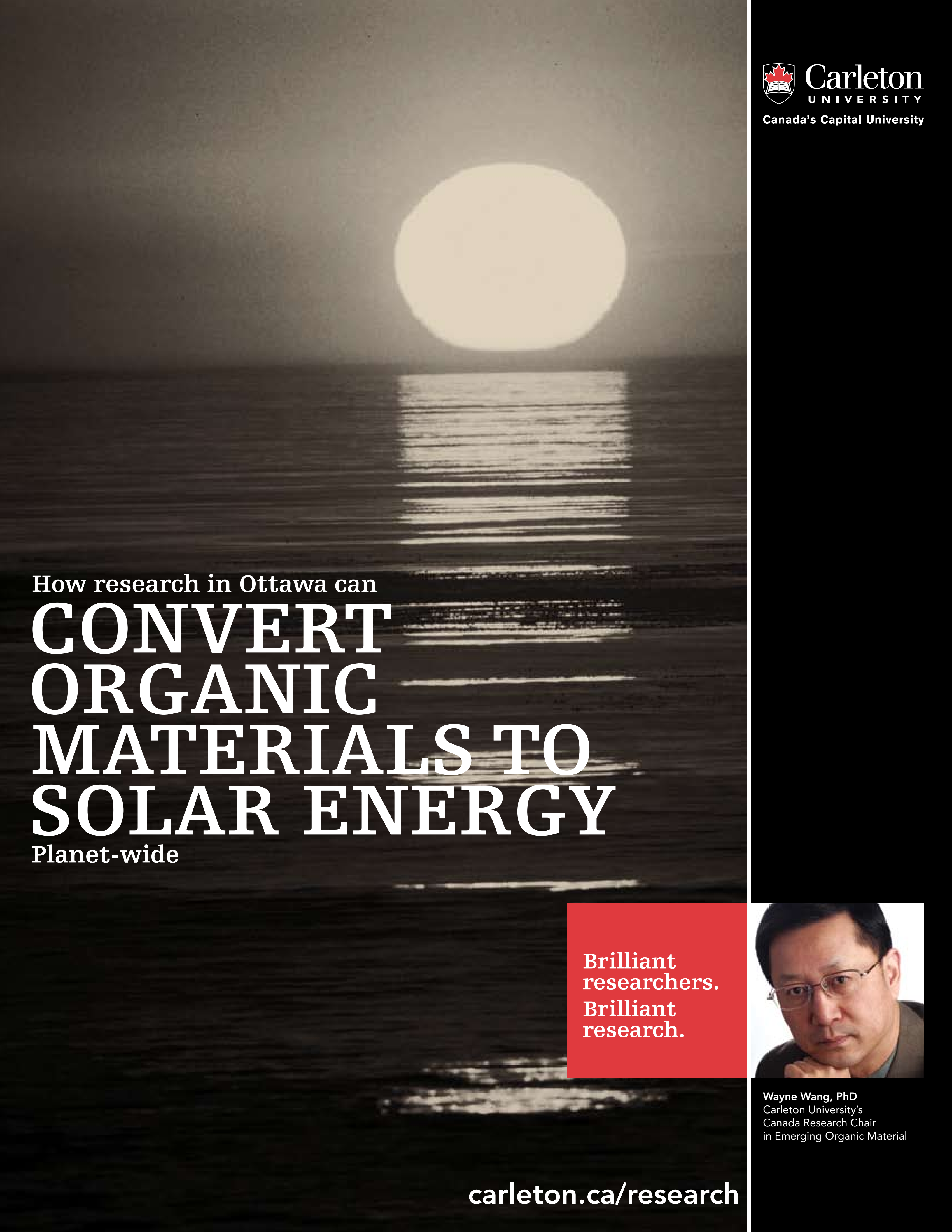
Carleton UNIVERSITY
Canada's Capital University
How research in Ottawa can
CONVERT ORGANIC MATERIALS TO SOLAR ENERGY
Planet-wide
Brilliant researchers. Brilliant research.
Wayne Wang, PhD
Carleton University's
Canada Research Chair
in Emerging Organic Material
carleton.ca/research

Brilliant researchers. Brilliant research.

Switch on the light: using organic materials to harness solar energy

Research snapshot

Purpose
To study the electrical and optical properties of organic solids and polymers (long strings of repeating molecular units).

Scope
To search for organic molecules and polymers that can emit or absorb light within the NIR (near infrared) spectral region.

Thesis
Organic materials that are electrically, optically or thermally active at wavelengths of 800-2000 nm can be processed and applied in a variety of settings.

Outcome
To use synthetic polymers, long strings of repeating molecular units, to boost the performance efficiency of various optoelectronic devices.

Selected publications
- Y. Bai, N. Song, J. P. Gao, X. Sun, X. Wang, G. Yu, Z. Y. Wang, "A New Approach to Highly Electrooptically Active Materials Using Cross-Linkable, Hyperbranched Chromophore-Containing Oligomers as a Macromolecular Dopant." *Journal of the American Chemical Society*, 127, 2060-2061 (2005).
- S. Xun, G. LeClair, J. Zhang, X. Chen, J. P. Gao, Z. Y. Wang, "Tuning the Electrical and Optical Properties of Dinuclear Ruthenium Complexes for Near Infrared Optical Sensing." *Organic Letters*, 8, 1697-1700 (2006).

Grad student projects
Yuxing Cui,
second-year student
Master's of Science in Organic Chemistry
Study of Infrared Reflective Coatings

Gaetan LeClair,
third-year student
PhD in Organic Chemistry
Development and Applications of Organic Near Infrared Materials

Honours
- 2004 JSPS Senior Visiting Fellowship (Japan)
- 2006 Macromolecular Science and Engineering Award (Chemical Institute of Canada)
- 2006 Research Excellence Award (Carleton University)

"Organic solids and carbon-based polymers are the stuff of modern life; without them, products such as Gore-Tex clothing, latex gloves, and nylon stockings would not exist. Chemists synthesize carbon compounds that have particular characteristics, such as water-resistance, stretchiness, and "mouldability."

Organic chemist Wayne Wang believes that the optical and electrical properties of some carbon compounds are equally useful and over the course of a 15-year career, he has become a specialist in organic materials that interact with light and electricity.

At Carleton University, where he holds the Tier I Canada Research Chair in Emerging Organic Materials, Wang studies organic solids and polymers to determine if they absorb certain kinds of light. He also designs new molecules that have specific characteristics such as optical properties, and goes one step further by processing compounds to produce materials with commercial applications.

He is not the only chemist interested in optically and electrically active organic materials but his current research has a twist. "To date we have worked successfully with compounds that interact with ultraviolet and visible light but I am interested in what we can do with invisible light. Emerging materials, to me, are those that work with non-visible light and could be used to develop advanced photonics and telecommunications technologies."

CAPTURING NEAR INFRARED RAYS

When Wang talks about non-visible light, he means infrared rays with wavelengths of 800-2000 nanometers, which are found in the near infrared range (NIR) very close to visible light in the electromagnetic spectrum.

This non-visible light has two main advantages. Unlike gamma rays or ultraviolet light, it has lower energy so is less damaging for living organisms. Also, most of the sun's infrared rays fall within this range, which makes for a plentiful supply.

According to Wang, by finding organic materials that interact with NIR rays, we will increase the usable solar energy at our disposal. "Right now, we can only convert ultraviolet and visible light or roughly 70 percent of the sun's power. Trying to capture the other 30 percent makes sense—all we need are the right materials."

THE CENTURY OF THE PHOTON

Optical applications have revolutionized medical techniques such as examination, diagnosis, therapy and surgery. Further breakthroughs appear to be within reach—such as micro-probes that use NIR which "sees more deeply because it can penetrate further than visible light into human tissue."

Likewise, researchers are working on a new generation of "smart" technologies, such as carbon-based coatings that can not only absorb light but turn this property off and on in response to an electrical current. When applied to windows, these coatings would give users the ability to control the amount of infrared light that passes through the glass with the flick of a light switch. For Wang, such applications are not only examples of how emerging organic materials can be used to develop sophisticated technologies but also proof that history repeats itself.

As he points out, over time the identification of a major technological principle has often triggered the creation of new industries for decades to follow. The transistor, immediately appreciated in 1948 as a new kind of electronic, paved the way for the microelectronics industry and the computer age. "Just as the electron enabled the technological breakthroughs of the 20th century, the 21st century will very likely prove to be the century of the photon."

"I am now interested in what we can do with invisible light."

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