Frontier NANO

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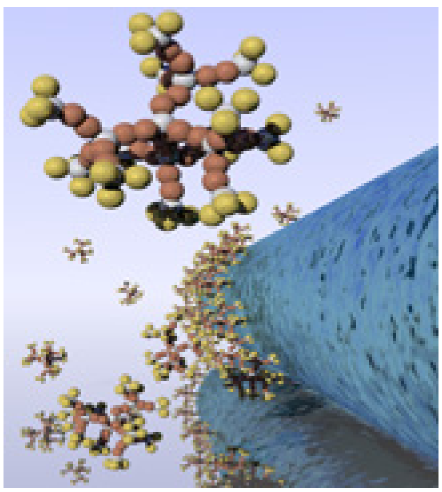
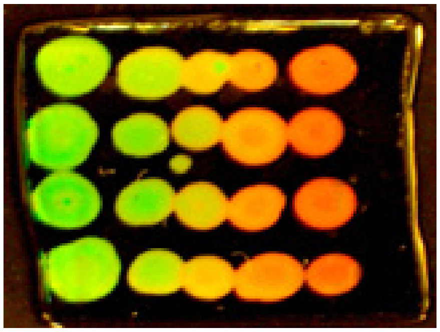
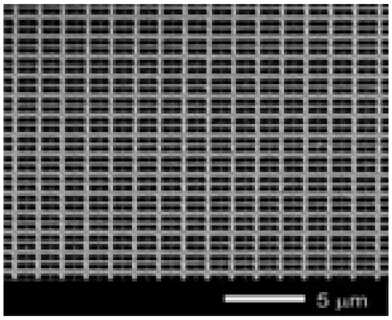


There is a buzz in the corridors of the Chemistry Department at the UoT, it is all about Nano, an incredibly small new world where things previously thought to be in the realm of science fiction are now being reduced to practice through Nanochemistry and on a daily basis. What is all this Nano buzz?

Talk over coffee of an entirely synthetic nanomachine with an on-board chemical power source, designed to perform a specific task, seems as fanciful as the adventures of the fictional communications officer Nano on the Enterprise exploring the Star Trek universe. Nanoscale polymer scaffolds that allow nerve cells to regenerate and partially restore leg motion of a rat with a spinal cord injury providing hope that paraplegics will someday walk again, sounds like a Marvel Comics story about the Early Voyages of Nano of the Lyrian race. Polymers with chains made of inorganic elements giving carbon-based polymers we have grown to love for over a Century a run for its money, impossible. Tiny chunks of everyday semiconductors comprising just a handful of atoms, collecting sunlight and converting it to electricity more efficiently than any solar cell we know today, would likely evoke a Nano smile from Albert Einstein, discoverer of the photoelectric effect. Nanoscale cleansing agents made of titania, the pervasive brightener in the whitest of paint, that seek-and-destroy toxic organic pollutants in waste water streams with a little help from sunlight, would make environmentalists think differently about what chemists do for a living. Add a few gold atoms to the titania and suddenly shower tiles clean themselves and odors in toilets disappear, all possible with Nano. Holey hybrids, exciting new classes of composite materials made of organics and inorganics, and permeated with nanoscale voids encapsulate drug, perfume, herbicide and insecticide molecules, can on-demand release them exactly when and where we want them. The air holes in these materials also endow them with the amazing ability to prevent deleterious electrical cross talk between the smallest fastest Nano transistors and wires on the semiconductor roadmap for next generation silicon chips. Chemically synthesized mimics of opal gemstones and butterfly wings (Nature's geological and biological 3D diffraction gratings that enrich our world with color from structure rather than pigments), manage light akin to how the silicon Samurai controls electrons and have shown the way to a new generation of Nano photonic crystal computer chips, full color displays, ultrahigh density data storage, security encryption, fingerprint recognition systems and chromatography stationary phase that separate and detect analytes. All this Nano is the stuff loved by venture capitalists seeking to become rich by investing in Nanotechnology. All this and more is happening in the Chemistry Department at the UoT.



No wonder there is a buzz about Nano! But what is Nano? How did it begin? And why did it explode in such a dramatic way into the scientific and public consciousness and so recently? Nano-, prefix denoting a factor of 10^{-9} has its origin in the Greek *nanos*, meaning dwarf. The term is usually associated with the time interval of a nanosecond, a billionth of a second, and the length scale of a nanometer, a billionth of a meter or ten Angstroms. In its broadest terms, Nanoscience and Nanotechnology congers up visions of making and imaging, manipulating and utilizing things very small. Within this world of the small the dream of an industrial revolution based on such tiny objects may have seemed far fetched about half a century ago when Feynman at Caltech gave his prophetic lecture "*Plenty of Room at the Bottom*", but now we find ourselves in the midst of a Nanotechnology revolution the impact of which will effect all of our lives in one way or another. In his talk Feynman imagined a science of Nano in which totally synthetic constructions could be created through chemistry and auto-assembled with unprecedented nanoscale precision, to create purposeful architectures that could perform a useful task.



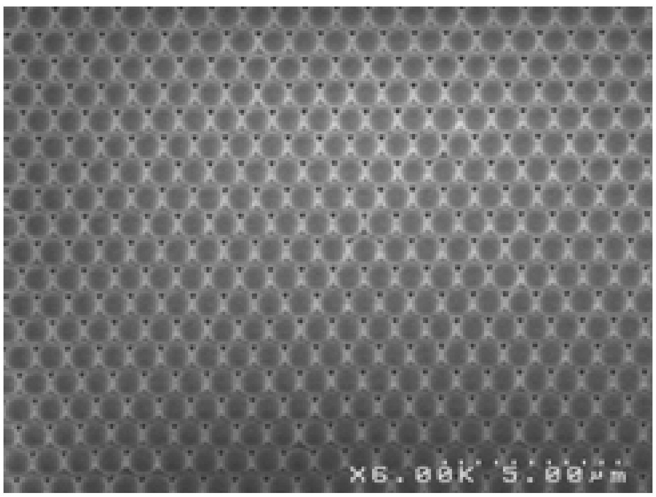
Since Feynman's prescient speech, the field of Nanoscience has crystallized from its initially amorphous poorly defined state with a science fiction aura to a form that is beautiful and recognizable in terms of the innovation and significance of the science, and spectacular with respect to its potential for spawning new and exciting technology. In reality, in just the past ten years the power of Nanoscience research has begun to realize its full potential and its presence has raced across the globe and begun to influence most walks of life in many countries. It is now widely accepted by the scientific and industrial, government and business communities that Nanoscience will be the engine that drives Nanotechnology, touted to be the next industrial revolution.

It is said these days that a hallmark of Nanoscience is its interdisciplinary nature - its practice requires researchers to cross the traditional boundaries between the experimental and theoretical fields of chemistry and physics, materials science and engineering, biology and medicine, to work together in close-knit teams on challenging problems of global importance. Communication and collaboration between these disciplines will enable the biggest and most pressing scientific problems to be tackled, considered necessary if Nanotechnology is to be successfully exploited. This is a daunting task for students and researchers, technology transfer and funding agencies, industry and government, as the field of Nanoscience and its translation into Nanotechnology is so diverse and evolving rapidly.

To be a major player in the highly competitive science and technology of Nano, the Center for Polymeric and Inorganic Nanomaterials (CPIN), housed in the Chemistry Department of the University of Toronto, was recently created. Director Mitch Winnik and Principle Investigators Eugenia Kumacheva, Ian Manners, David James, Greg Scholes, Molly Schoichet, Andre Yudin and Geoffrey Ozin together were instrumental in writing the successful proposal to CFI that founded CPIN and established its state-of-the-art Nanochemistry facilities, with five years of infrastructure funding to maintain the facility in top-notch working order.

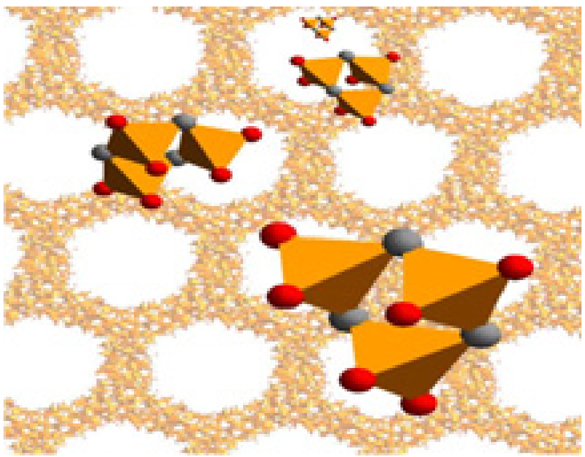
In just a few years since its inception CPIN has become a hotbed for leading-edge research in the emerging field of Nanochemistry. Its mandate is to assemble under one roof some of the world's most creative Nanochemistry researchers and attract a large cohort of top rank graduate and post graduate students and provide them collectively with the most sophisticated and powerful tools to synthesize and study a range of novel Nanostructures for a number of perceived applications in Nanotechnology.

CPIN is fully operational and the Nano adrenaline is flowing fast. Published work emerging from the center is making its way to top rank journals like Nature and Science, an impressive patent portfolio of Nano intellectual property is growing fast with licensing of Nanotechnology and Nano spin-off companies emerging and on the horizon, and the first teaching text book on Nanochemistry: A Chemical Approach to Nanomaterials by yours truly will be published in June by the Royal Society of Chemistry. *The impact of CPIN is already being felt worldwide!*



Nanochemistry in one of its many guises pervades all of these CPIN projects and within the world of the small they are all knocking at the Frontier of Nano! Research in CPIN is promoting synergies amongst UoT chemistry faculty and students and is encouraging collaborations with researchers in other UoT departments, as well as outside universities and industries in Canada and other countries.

CPIN infrastructure is world class and is enabling chemistry researchers to carry out highly innovative and internationally competitive Nanochemistry research. The emphasis of Nanochemistry research and its ultimate scientific impact will be the fundamental science contributed by chemists, particularly their close collaborations with physicists (to develop novel nanostructures and evaluate their properties, functions and utility), theorists (to guide in the choice of the most promising areas and help explain and model observed phenomena), electrical and computer engineers (to point the way to applications), materials scientists (to evaluate nanomaterials and nanostructures) and biological and medical scientists (to apply nanomaterials to problems in biology and medicine). Nanomaterials emerging from CPIN research are expected to evolve towards engineering issues and involve materials and engineering scientists (to develop necessary fabrication and processing techniques to implement nanostructures), process, device and system designers and engineers (to characterize the performance of nanomaterials and nanostructures and who can integrate them into useful products to improved performance).



CPIN will allow chemistry faculty to train students in every aspect of state-of-the-art Nanochemistry, recognized as critical to the technological and economic future of Canada. These students will represent a national resource that will contribute an exceptional and lasting benefit to Canada. CPIN research will contribute to the fundamental knowledge base of Nanoscience and ultimately to an increase in Canadian economic activity, as it will help Canadian industries increase their global competitiveness in the burgeoning field of Nanotechnology. Without CFI infrastructure support CPIN would not exist and none of this would have been possible!