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# Inspiration...From Nature to Inorganic Chemistry: Coordination Complexes Are More Than Pretty Colors; They Are Potential Solutions to Problems in Molecular Electronics, Alternative Energy and Cancer Treatment

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# Inspiration...from nature to inorganic chemistry

**Coordination complexes are more than pretty colors; they are potential solutions to problems in molecular electronics, alternative energy and cancer treatment**

Although it was once thought that inorganic compounds couldn't occur in living organisms, metal compounds are now known to be the driving force behind many vital processes in nature – from the mechanism of oxygen production in photosynthesis to keeping many proteins and enzymes working.

Cláudio Verani, Ph.D., associate professor of chemistry in Wayne State University's College of Liberal Arts and Sciences, is working to understand how the ingenuity of metals in nature can inspire solutions to human dilemmas – from information storage to renewable energy to cancer treatment. For these endeavors, he is using some of the most vibrant metal compounds as a starting point for developing new molecular materials in the lab.

"We call this 'bioinspired chemistry' because nature inspires our synthetic design," he said.

Verani is a bioinorganic chemist, which means he models the properties of inorganic systems to understand how important processes such as oxygen activation and electron transfer work. He is specifically focused on coordination complexes – structures consisting of a central transition metal ion that is bonded to surrounding organic ligands.

Coordination complexes are often spectacular in color because of electronic transitions caused by the absorption of light. It was this characteristic that first attracted Verani to studying them. "It comes back to color – deep blues, reds and greens. I was fascinated by this aspect," he said. "It was a combination of curiosity about the electronic mechanisms that explain the existence of such colors and the vital role of these compounds in nature that led me to my current work."

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"We call this 'bioinspired chemistry' because nature inspires our synthetic design."

— Dr. Verani

Supported by a second cycle of National Science Foundation funding, Verani and his team of researchers are addressing an impending dilemma in computing by exploring alternative, molecule-based forms of data storage. Verani's group pioneered the use of redox-active metal surfactants for molecular electronics. These materials can stabilize charge, enabling the reading and writing of information processes in the form of organic radicals. "The growing need for information storage is a concern our society faces, and alternative technologies must be found quickly," Verani said. He proposes that these compounds could be used to create smaller circuits able to handle larger storage densities without undesired production of heat.

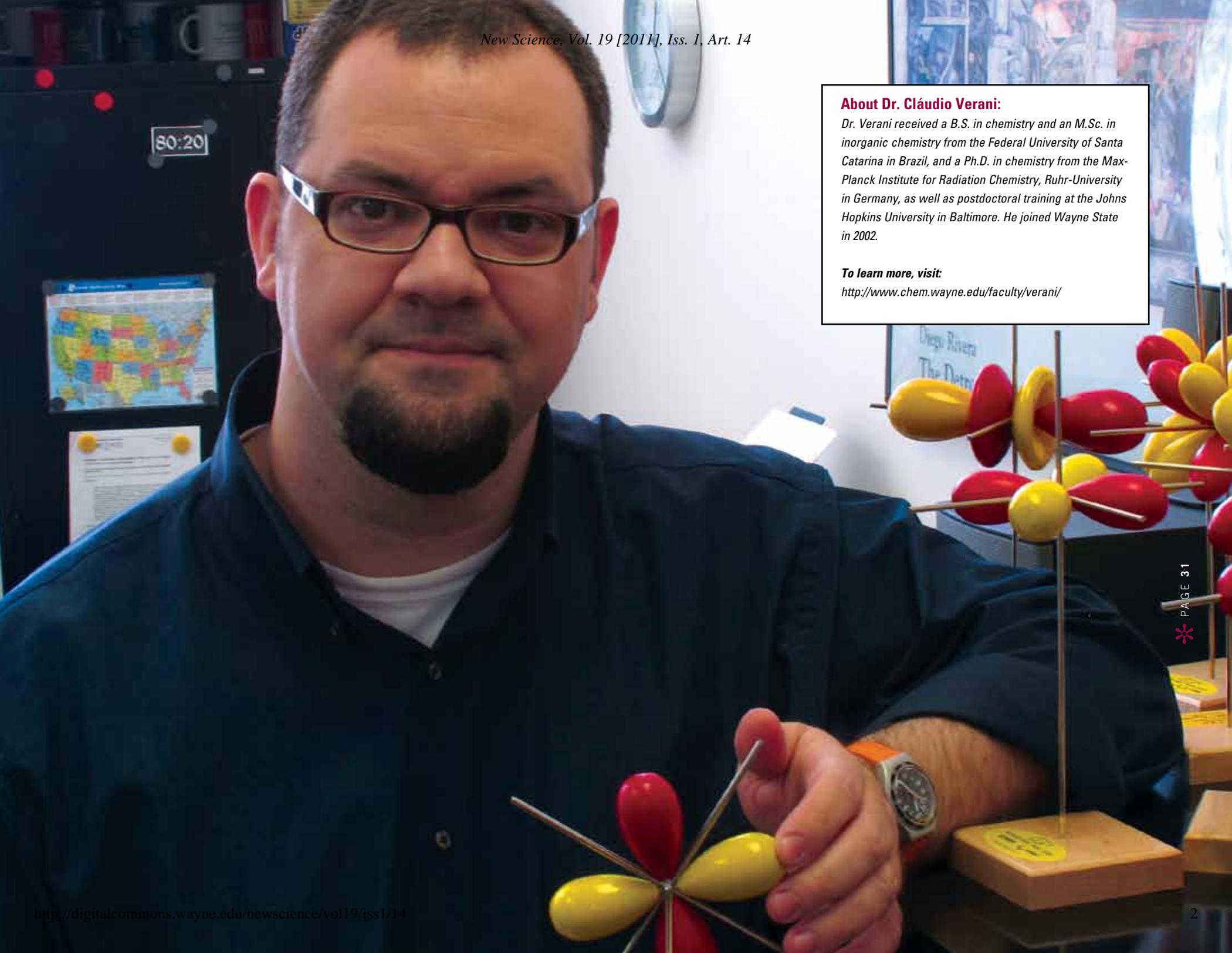
With funding from the Department of Energy, Verani is also conducting fundamental research that could pave the way to the highly anticipated hydrogen economy. Along with John Endicott, Ph.D., professor emeritus of chemistry and an authority in photophysics, and Bernard Schlegel, Ph.D., professor of chemistry and an expert in chemical computations, both from Wayne State, they are working to understand the mechanisms of water splitting. This process breaks water into

dihydrogen – a clean, renewable alternative to petroleum – and dioxygen. Inspired by photosynthesis, the team hopes to understand the design of compounds that contain several different metal centers capable of accumulating the charge needed for water splitting. Verani is also addressing the design of multimetallic catalysts capable of forming films. "If we can understand how to split water into its two basic components, we may be on our way to fuels that require only water and sunlight for production," Verani said.

In addition, Verani is working with Ping Dou, Ph.D., professor of oncology, pharmacology and pathology in Wayne State University's School of Medicine and the Karmanos Cancer Institute, to understand and develop metal-containing anticancer drugs. The pair's research targets are cellular proteasomes – large enzyme complexes that regulate the degradation of hazardous and cell-damaging defective proteins. "Proteasomes are present in healthy cells, but are much more abundant in cancer cells," Verani said. "By understanding how metal complexes bind with proteasomes, we hope to learn how to target the proteasomes of cancer cells, selectively leading them to apoptosis – programmed cell death."

In all his current work, Verani emphasizes nature's influence on the design of his synthetic compounds. "This research requires a lot of work and an open mind," he said. "Coordination chemistry offers the best starting point for our synthetic strategies. In understanding these processes, we can improve quality of life through the development of new technologies and future drugs."





**About Dr. Cláudio Verani:**

*Dr. Verani received a B.S. in chemistry and an M.Sc. in inorganic chemistry from the Federal University of Santa Catarina in Brazil, and a Ph.D. in chemistry from the Max-Planck Institute for Radiation Chemistry, Ruhr-University in Germany, as well as postdoctoral training at the Johns Hopkins University in Baltimore. He joined Wayne State in 2002.*

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<http://www.chem.wayne.edu/faculty/verani/>