World Congress on Biomimetics, Artificial Muscles and Nano-Bio 2007

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EDITORIAL

World Congress on Biomimetics, Artificial Muscles and Nano-Bio 2007

Guest Editor

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Life—biological cells and organs—combines technological elegance with great efficiency in transforming chemical energy at constant temperature into functions. Inside any living cell thousands of simultaneous reactions occur. Every reaction promotes changes in intramolecular and intermolecular interactions. Most of those reactions link conformational changes of biopolymers with ionic and electronic movements pushing water flow. Living cells are constituted by reactive, soft and wet materials. Actuation of natural organs such as muscles involves, moreover, a chemical reaction (ATP hydrolysis). Simultaneous sensing processes provide living creatures with a perfect consciousness of both the characteristics of the mechanical movements and their interactions with the environment: they are intelligent devices.

Nowadays models of the chemical kinetics do not include any quantification of either the changes in the molecular interactions inside the system during reaction or structural information about the conformational changes of enzymes or reactive proteins. From our point of view this is one the most important scientific challenges for the 21st century, involving responses to questions related to life, health and illness. Those responses, due to the magnitude of the challenge, can only be explored by cooperative work involving chemists, physicists, engineers, biologists or clinicians.

Many technological advances developed by humans are inspired by biological systems, organs or devices present in living creatures. The main difference between human technology and natural organs is changes in chemical composition occurring inside the wet natural organ during actuation: they are reactive, soft and wet materials. Our artificial machines are constructed from dry materials that keep their composition constant under actuation.

This is the context designed for the consecutive World Congresses on Biomimetics, Artificial Muscles and Nano-Bio, and more specifically for the fourth such one held in Torre Pacheco, Spain, on 6–9 November 2007: www.upct.es/~nano-bio/index.htm.

Any attempt to produce biomimetic devices must include chemically reactive materials including water and ions. Considering that biological organs include biopolymers and that their actuation is triggered by a nervous pulse (electrical pulse), polymers and electric pulses are included in most of the devices. When those devices produce mechanical energy and macroscopic movements they are called artificial muscles: electromechanical when they do not include chemical reactions or electrochemomechanical when chemical reactions support the actuation.

Advances in electromechanical artificial muscles consisting of a film of ionic polymer–metal nano-composites coated with two metallic electrodes are presented by Shahinpoor's group. When the polymer chains are influenced by physical or chemical variables from the environment, the triple layer produces an electrical signal proportional to the shifted variable and the device becomes, alternatively, a sensor.

The contributions from Kaneto's and Otero's groups present two complementary aspects of electrochemomechanical wet devices where the conformational energy keeps the central role in training, fatigue and aging effects

studied by repeat oxidation–reduction cycles under tensile loads, and for the unique simultaneous actuation and sensing abilities of those devices, mimicking those from natural organs. Consideration of the chemical reaction allows the quantification of the conformational energy as a constituent of the activation energy.

The electrochemical reaction promotes in conducting polymers a progressive change in the potential gap between occupied and unoccupied electronic levels, the gap energy coming into the visible region. Thin films change their light absorbance under electrochemical control (chameleonic material) and Padilla shows that the maximum contrast is achieved with film of an intermediate thickness.

The sensing abilities of artificial polymers are extended to natural crustacyanin proteins, extracted by Aldissi's group from lobster shells, that sense infrared radiation and can be used as an electro-optic thermal sensing device, having both high sensitivity and fast response, which is enhanced by the deposition process.

The Toh group presents alumina membranes which allow selective transport of charged proteins, similar to biological membranes, by controlling the potential gradient between Pt deposited on both membrane surfaces.

The Tozzi group presents a robust intelligent implantable robot based on shape memory alloys to restore the pump function of the atrium in patients suffering from chronic atrial fibrillation.

The 4th World Congress on Biomimetics, Artificial Muscles and Nano-Bio was dedicated to the memory of Professor A MacDiarmid who had accepted both his participation as a plenary lecturer at the congress and his nomination as honorary doctor by the Universidad Politécnica de Cartagena. Unfortunately he passed away some months before the beginning of the meeting, depriving us of his clever lecture and of his permanent support in developing new aspects of conducting polymers.

During the meeting we enjoyed a beautiful ceremony where Professor Yoshihito Osada received an honorary doctorate from the Universidad Politécnica de Cartagena, paying tribute to his outstanding contribution in the field.

Finally, thanks are due to the editorial and production team of *Bioinspiration & Biomimetics* for their continued support and management of the review and preparation process in an entirely efficient and professional manner. Thanks are due to those institutions that have contributed in different ways to the final success of the meeting: MEC, ISE, UPCT, IBERNAM and the Autonomous Government of the Murcia Region. Special thanks go to all the participants who have contributed to this issue of *Bioinspiration & Biomimetics* at the forefront of steps towards the biomimetics of materials, properties and models.