



**Draft Abstract
for a**

Young Chemists' Workshop

Electroactive Polymers for Artificial Muscles

Organizer: Daniel Brandell (Materials Chemistry, Uppsala University, Sweden)

ElectroActive Polymers (EAPs) are polymeric materials which change their shape in response to electrical stimulation. The process can work in both directions; an EAP can function either as a sensor (where it gives electrical output from mechanical input) or an actuator (where electrical input gives mechanical output) as in human muscles and nerves. The properties of EAPs are rather similar to biological muscles in terms of force, strain and speed. They are therefore interesting as a basis for building biomimetic devices; *i.e.*, artificial muscles which functions in robotic limbs. EAPs have many advantages compared to traditional electromechanical robotic devices. They are mechanically simpler, lightweight and easy to miniaturize; they are soft and flexible, with a high degree of freedom; their motion is noiseless. Compared to other types of electromechanical transducer, such as piezoelectric materials, ionomeric transducers have the advantage of high-strain output (>9% is possible), low-voltage operation (typically less than 5 V), and high sensitivity in the charge-sensing mode. With these properties, EAPs are considered to be the most promising materials in the future for constructing artificial muscles for both disabled and able-bodied persons.

There are two types of EAP – electronically and ionically conducting. This YCW proposal focuses primarily on the ionically conducting type. Since these require several orders of magnitude lower voltages, they will have a much better chance to work in a human environment. The archetypal ionically conducting EAP is an ionomeric polymer-metal composite (IPMC), where an ionomeric polymer sheet (typically Nafion®) is coated on both sides with a thin metal film. When a potential is applied across the film, the material bends towards the anode; thereafter, it relaxes back towards its initial position.

EAPs are truly Materials of Tomorrow. The field is emerging rapidly; there is a steady growth of new materials being proposed, new patents, and new prototype development. This is one further area: the first commercial IPMC product (a fish robot from Eamex, Japan) was announced in 2003. Today, the leading groups in this area exist in USA and Asia (at the major international conference on artificial muscles, EAPAD, Europe usually contributes with only ca. 10% of the presentations). There is therefore a clear need to draw together European competence in the field in form of a YCW.

The workshop will include the following topics:

- Synthesis of new EAPs for artificial muscles
- Electrode morphology and electrode/ionomer interactions
- Coated IPMCs to function in non-aqueous environments
- Electromechanical monitoring of EAP performance
- Use of EAPs in robotic applications
- Atomistic simulations of EAP materials
- Finite Element Analysis (FEA) modelling of IPMCs