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TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע"ש וולפסון
The Wolfson Department of Chemical Engineering

**Wolfson Department of Chemical Engineering Seminar**
**Lecture Hall 6, Wolfson Department of Chemical Engineering,**
**Wednesday, January 29th, 2020 at 13:30**

# Fiber-based anodes for decoupled water splitting for $H_2$ production

**Shabtai Hadash**
Advisor: Prof. Gideon Grader

Hydrogen is a clean fuel that can be stored, transported, and converted to electrical energy on demand, with water being the only side product. Water splitting (electrolysis) is considered as one of the most well-established technologies for $H_2$ production. To improve the compatibility between water splitting technologies and renewable power sources, decoupled water splitting has recently emerged as a promising research field. We have developed an electrochemically-thermally activated chemical (E-TAC) water splitting cycle, a breakthrough method for hydrogen and oxygen evolution (HER and OER, respectively) in two distinct steps separated in time and space with pure (>98%) $H_2$ production at overall higher voltage efficiencies compared to traditional electrolysis. The E-TAC process is principally based on the oxidation of a $Ni(OH)_2$ anode, replacing the OER anode, followed by its spontaneous chemical reduction upon heating

Thus far, we have used anodes prepared by electrodeposition of $Ni(OH)_2$ onto a conductive nickel foam substrate. This work provides an alternative route to anode fabrication, utilizing electrospinning (ES) to prepare high-surface area substrates comprised of nickel nanofibers (NFs) with controlled morphology, followed by an electro-oxidation step to form a $Ni/Ni(OH)_2$ core/shell hybrid anode structure.The effect of various parameters on the anode's composition, mechanical stability and electrochemical performance was studied, including: the effect of different ES parameters: thermal treatments (heating profiles and atmosphere) on the resulting fiber morphology, the effect of porosity and binder content on the anode's mechanical stability, the influence of the $Ni(OH)_2$ growth technique on the mass loading of $Ni(OH)_2$, and the influence of dopants (Co and Fe) on the electrochemical properties. The E-TAC performance of fiber-based anodes was compared to that of electrodeposited anodes at different charging potentials, states of charge (SOC) and depth of thermally activated discharge, demonstrating improved performance in several important operation parameters.

# Shear thinning pectin hydrogels physically cross-linked with chitosan nanogels

**Yulia Shitrit**
Advisor: Prof. Havazelet Bianco-Peled

Self-assembly via non-covalent crosslinking provides a route to form injectable hydrogels with shear-thinning and self-healing properties arising from dynamic and reversible crosslinks. Shear-thinning behavior enables a pre-formed hydrogel with desired physical properties, as characterized ex vivo, to be delivered in vivo via application of shear stress during injection.

In this study the development of a polymer-nanogel hydrogel based on a pair of polysaccharides is reported for the first time.

Shear thinning and self-healing behavior were demonstrated using rheology tests. The influences of the nanogels size and quantity on the recovery rate and gel properties were evaluated using DLS, swelling and strength tests.

The nanogels act as crosslinking agents between pectin chains, leading to the formation of thermos-responsive hydrogel. Due to the dynamic interactions between the chains and the nanogels, the formed network dissociates under applied shear, allowing the hydrogel to flow. Moreover, elimination of the applied shear results in exceptionally fast and comprehensive recovery of the storage modulus, reverting the mixture back into solid form. This novel hydrogel displays network recovery suitable for injectable biomedical applications, while benefiting from the advantages of nanogels as carriers.

Our current project focused on studying the nanostructure of the gel in order to better understand the interaction parameters and the influence of hydrogen bonds and electrostatic interactions inside the gel matrix.

Moreover, we are working on dual drag delivery system based on these hydrogels, in which one drug will be released from the nanogels and second drug will be released from the gel matrix in different rates.

**Refreshments will be served at 13:15**