TCESC
Technion Chemical Engineering Student Conference

Poster and Flash Talk list

1. Rawan Halabi - Professor Yoed Tsur, Technion **(Poster)**.
2. Vivian Darsa-Maidantchik - Professor Hossam Haick, Technion **(Poster & Flash Talk)**.
3. Ofri Vizenblit - Dr. Assaf Zinger lab, Technion **(Poster & Flash Talk)**.
4. Galia Hendel - Professor Havazelet Bianco-Peled, Technion **(Poster)**.
5. Oshrat Regev - Professor Havazelet Bianco-Peled, Technion **(Poster)**.
6. Jin Wang - Professor Oz Gazit, Technion **(Poster)**.
7. Edwar Odeh - Dr. Shady Farach lab, Technion **(Poster & Flash Talk)**.
8. Sapir Rappoport - Professor Yeshayahu Talmon, Technion **(Poster)**.
9. Gilad Sasson - Professor Tamar Segal Peretz, Technion **(Poster)**.
10. David Ben Shlomo - Professor Ronen Berkovich, Ben-Gurion university **(Poster)**.
11. Manar Halabi - Professor Oz Gazit, Technion **(Poster)**.
12. Paz Pekerman - Professor Havazelet Bianco-Peled, Technion **(Poster)**.
13. Eitay Shtayinberg - Professor Yaron Paz, Technion **(Poster)**.
14. Dana Wirzeberger - Professor Havazelet Bianco-Peled, Technion **(Poster)**.
15. Zihua Chen - Professor Dario R. Dekel, Technion **(Poster)**.
16. Shir Erez - Dr. Assaf Zinger lab, Technion **(Poster & Flash Talk)**.
17. Ester Korkus Hamal - Professor Yachin Cohen, Technion **(Poster)**.
18. Syeda Mushrifa-Zahan - Professor Dario R. Dekel, Technion **(Poster)**.
19. Mattan Becker - Professor Ronen Berkovich, Ben-Gurion university **(Poster)**.
20. Yifan Li - Professor Ofer Manor, Technion **(Poster)**.
21. Or Peleg-Evron - Professor Havazelet Bianco-Peled, Technion **(Poster)**.
22. Kfir Kaplan - Professor Alon Grinberg Dana, Technion **(Poster)**.
23. Lital Felzenshtein - Professor Yaron Paz lab, Technion **(Poster)**.
24. Irina Davidovich - Professor Yeshayahu Talmon lab, Technion **(Poster)**.
25. Sapir Lifshiz-Simon - Professor Yeshayahu Talmon lab, Technion **(Poster & Flash Talk)**.
26. Rand Shibel - Professor Hossam Haick lab, Technion **(Poster)**.
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31. Ravit Arbel - Professor Avi Schroeder, Technion **(Flash Talk)**.
32. Oren Bachar - Professor Omer Yehezkeli lab, Technion **(Flash Talk)**.
33. Wisal Khalaily - Professor Yoed Tsur lab, Technion **(Flash Talk)**.
34. Nathan Blank - Professor Guy Ramon lab, Ben-Gurion university **(Poster)**.
35. Margarita Antonenko - Professor Yachin Cohen lab, Technion **(Poster)**.
36. Itzhak I. Maor - Professor Gideon Grader lab, Technion **(Poster, Flash talk)**.
37. Sivan Barash Shahar - Dr. Assaf Zinger lab, Technion **(Poster, Flash talk)**.

Rawan Halabi *(Poster #1)*

Professor Yoed Tsur lab, Technion

THE INFLUENCE OF POINT DEFECTS ON FLASH SINTERING OF MGO

Foreign and native point defects play an important role in mass transfer during sintering of ceramics. Additionally, there has been a long-standing debate about the mechanism controlling the flash sintering event [1,2]. In order to study the influence of point defects on flash sintering, magnesium oxide was chosen as a model system. MgO has a rock salt dense structure, hence the main native point defects are vacancies. An ion in the MgO lattice can diffuse only via a vacancy mechanism into which it jumps. Cation substitutional doping usually involves also strain due to size mismatch of the cations. However, it is possible to somewhat limit that strain in MgO by using similar sized dopants. The possible candidates are Li1+ (acceptor), Sc3+ (donor), and Zn2+ for isovalent doping. The Mg2+ ionic radius is 72 pm in six-fold coordination; Li1+ is 76 pm; Sc3+ is 75 pm; and Zn2+ is 74 pm. Doping with lithium enhances the oxygen vacancies concentration, while doping with scandium enhances the Mg vacancies concentration. Doping with zinc is not likely to create any vacancy defects if the temperature is well below sublimation of the relevant constituents. In this research, we consider low doping levels, below the solubility limits, to prevent creation of secondary phases. Initial results of FS experiments of doped MgO in a dedicated dilatometer will be presented. As can be seen in figure 1, the results suggest that oxygen vacancies are important for flash.

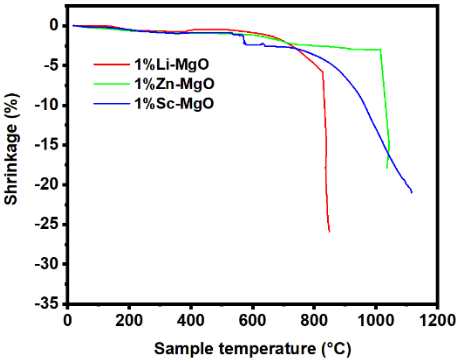

Figure 1 – Comparison of shrinkage behaviour as a function of temperature of doped MgO at 2400 V/cm, showing that only Li- and Zn-doped MgO were flash sintered at these conditions.

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Vivian Darsa-Maidantchik *(Poster #2, Flash Talk #1)*

Professor Hossam Haick lab, Technion

Personalized approaches using volatolomic analyses and smart electronic devices to enhance breast cancer management

In recent years, Chemosensitivity and Resistance Assays (CSRAs) such as MTT and ChemoFx assays have been used to gain insight into a patient's cancer. This technology allows clinicians to assess the likelihood of the cancer responding to specific treatments, as well as to guide treatment decisions. Disadvantages of in vitro methods are the long wait time for results, the requirement for a substantial amount of tissue, and the growth rate of tumor cells which differs from in vivo. Thus, more reliable data may be attained via detection and monitoring of cancer-related Volatile Organic Compounds (VOCs) in vivo, alongside biocompatible sensing technology.

A volatolomic analysis of human healthy and cancerous tissues was conducted utilizing Gas Chromatography-Mass Spectrometry (GC-MS). Moreover, a novel hierarchical stacked geometrical configuration (HSGC) was developed using graphene oxide-based sensors functionalized with diethanolamine printed on free-standing cellulose films to swiftly acquire real-time spectrograms of VOCs. Furthermore, zinc nanoparticle-based sensors are being designed in polymeric bioresorbable films to obtain signals while delivering chemotherapeutic drugs in a regulated manner.

The GC-MS analysis demonstrated that alkanes, carboxylic acids, and phenols are the most effective substances that the sensor array can detect. HSGC device created chromatograms of VOC spectra in healthy and cancerous tissues in only 1-2 minutes, enabling it to serve as an alternative to cryo-section analysis (45-60 minutes), or a wearable spectrometer. Further research is focused on applying bioresorbable wearable sensor arrays to measure the effects of chemotherapeutic drugs on tissues in real-time.

By offering real-time data in the midst of cytotoxic treatment, we could drastically improve the lives of cancer patients. This newly developed device offers a revolutionary biomedical solution, as it can deliver faster, more accurate results in comparison to biopsies without additional effort.

V.D.M. acknowledges the Rappaport Technion Integrated Cancer Center for the Rubenstein fellowship.

Ofri Vizenblit *(Poster #3, Flash Talk #2)*

Dr. Assaf Zinger lab, Technion

The TAM's Effect- Modulating Triple Negative Breast Cancer Microenvironment Using Biomimetic Nanoparticles

Tumor-associated macrophages (TAM) play a significant role in promoting tumor spread, metastasis, and overall growth. Unfortunately, treatment approaches primarily target the tumor itself, overlooking the crucial role of the microenvironment and the associated TAM in supporting its growth and progression. Thus, recognizing the significant role of TAM in tumor development and the lack of targeted treatment approaches, we aimed to address this gap. In this work we demonstrate how “MPsomes” (i.e., membrane protein-based macrophage biomimetic nanoparticles) can modulate TAM population in triple-negative breast cancer (TNBC), directly affecting tumor propagation and tumor microenvironment cell composition. During this research, we used two biomimetic nanoparticle fabrication approaches and validated their stability for three weeks. Subsequently, we evaluated the effects of MPsomes treatment on cell population and overall tumor growth in a TNBC mouse model. Our results demonstrated a decrease in the number of macrophages within the tumor after administering MPsomes, resulting in a substantial slowdown of tumor growth compared to conventional liposome-based treatment. These findings demonstrate the remarkable potential of biomimetic nanoparticles as a drug-free and more efficient cancer-targeted platform for effectively treating TNBC.

Galia Hendel *(Poster #4)*

Professor Havazelet Bianco-Peled lab, Technion

Fabrication of food-grade nanoparticles to stabilize Pickering emulsions for 3D printing

3D food printing is an innovative technology to enable the creation of a wide variety of precise and personalized food products. The technology possesses many advantages such as convenience, customized design, flexibility and sustainability. The challenge is to create a yield-stress material with the appropriate rheological properties: A gel like substance that flows when stress is applied to pass through the nozzle, while behaving as solid at rest to hold the structure. A dynamic and promising type of yield-stress materials is an emulsion. They exhibit shear-thinning characteristics which are conducive to the extrusion fluidity, printability and stability of 3D printed objects. A classical emulsion is comprised of dispersed droplets of one immiscible liquid in another, such as oil and water, stabilized by emulsifiers. In Pickering emulsions, solid particles replace surfactants allowing for a more stable and non-toxic solution. The selection of plant-based solid particles enable a stable, vegan-friendly, economical and environmental solution. Particularly, pea protein, one of the most economically accessible proteins, has been gained interest due to health benefits, low cost, allergen and gluten-free claim. Pea protein can adsorb at the interface between the oil and water phases and create a network acting against phase separation, but this network is not stable over time. Despite its advantages, usage of pea protein in various fields is limited by its hydrophobicity, low solubility and tendency to aggregate in certain conditions. Therefore, it is difficult to obtain suitable stability at the droplet interface using pea protein as the sole stabilizer. K-carrageenan is an anionic, hydrophilic, viscoelastic hydrocolloid and may aid in reducing the size of hydrogels for nanoparticle fabrication.

The aim of this research is to create plant-based biocompatible nanoparticles with capability to stabilize food-grade emulsions for 3D printing. For the first time, particles constituting from pea protein isolate and K-carrageenan have been created and are investigated in relation to emulsifying abilities as seen in figure 1. These particles can be used in order to encapsulate unstable or sensitive molecules such as probiotics and drugs and the emulsion can be a basis for orally delivered additives, drugs and nutrients.

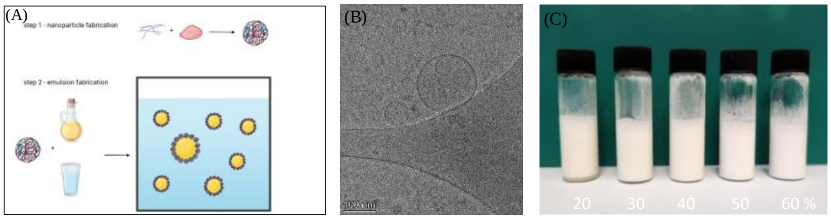


Figure 1 – (A) graphic illustration. Step 1 – K-carrageenan is combined with pea protein isolate power to fabricate nanoparticles. Step 2 – particles support stable oil in water emulsion. (B) Cryo-TEM image of the nanoparticles. (C) Stable oil concentration series, 20-60% oil content emulsions.

Oshrat Regev *(Poster #5)*

Professor Havazelet Bianco-Peled lab, Technion

Hydrogel formulation for sustained release of biomimetic nanoparticle and its effect on sepsis

Sepsis is a multifaceted clinical condition marked by an irregular host reaction to infection, which results in cellular and organ failure. The onset of sepsis arises when the immune response produces an excessive amount of pro-inflammatory cytokines, leading to physiological alterations in the host's body. Treating sepsis is both a significant human and economic burden, with a cost estimated to be over 16 billion dollars and an average hospitalization period of 20 days in the US. Despite being a major cause of death globally, with an estimated 30% mortality rate and 750,000 cases in the US alone, the underlying mechanism of sepsis is yet to be understood. Research suggests that the onset of sepsis may result from an imbalanced production of pro- and anti-inflammatory cytokines in response to the host's exposure and interactions with microbial products. Recently, novel nanoparticles (NPs) that mimic the membrane lipid and protein composition of leukocytes, have been developed by Zinger et. al. These NPs have previously shown a tendency to accumulate in inflamed tissues and to improve septic mice survival. The NPs interact with macrophages and affect their communication with inflamed endothelial cells, resulting in increased expression of anti-inflammatory cytokines and decreased expression of pro-inflammatory cytokines.

For the first time, a hydrogel formulation for controlled release of these novel biomimetic NPs was formed and the therapeutic effect of sustained-release instead of single-dose treatment is investigated. The controlled release formulation is a layer-by-layer self-assembly of tri-methyl chitosan (TMC)-alginate gel, while using the polysaccharides' polyelectrolyte properties to bind the NPs (Figure 1). The system's therapeutic potential regarding sepsis will be investigated by following the pro-inflammatory and anti-inflammatory cytokines, that have been shown to be impacted by a single-dose treatment.

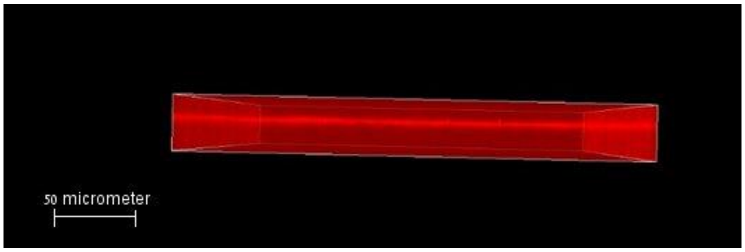


Figure 1: Spinning Disk Confocal microscope imaging of 1 layer of rhodamine-marked NPs in a layer-by-layer TMC-alginate hydrogel formulation crosslinked with $CaCO_3$.

Jin Wang *(Poster #6)*

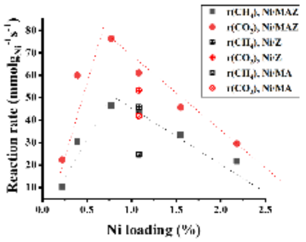
Professor Oz Gazit lab, Technion

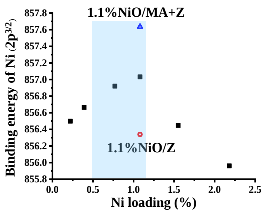
Enhanced DRM catalysis by Ni at heterointerfaces between thin $MgAlO_x$ and bulk ZrO_2

Recently, the dry reforming of methane is gaining much attention as a possible path to convert large amounts of two anthropogenic greenhouse gases to value-added chemicals [1]. The use of nickel (Ni)-based catalysts is the most commonly investigated. However, because Ni has a Tammann temperature of 590℃, the particles are prone to sintering and coke formation, both of which cause major deactivation [2]. In order to prevent the deactivation process it is important to stabilize the Ni on the support. This can be obtained through strong metal-support-interactions (S-MSI). However, if the MSI are too strong catalytic activity is suppressed [3]. The MSI can be tuned by using a thin oxide layer that acts as an intermediate between the Ni and the underlying support [4]. Tathod and Gazit et al. utilized MgAlOx nanosheet as the thin oxide and ZrO2 as the underlying oxide to form a so-called hierarchical support for Ni and were able to demonstrate significant promotion of DRM, long time stability and good selectivity. In that initial work it was clear that at lower Ni loading the properties of the Ni were significantly altered and in some cases were even amplified catalytically. In the current work, the location of the Ni particle on the hierarchical support is thoroughly investigated. We focus on Ni loading of 0.2- 3% to investigate the structure function relationship based on Ni location.

The thin oxides were obtained by the calcination of MgAl layered double hydroxide nanosheets deposited on a ZrO2 surface. Reaction testing was conducted in quartz tube reactor and the gas stream analyzed using gas chromatography. The density functional theory calculations were performed by the Montemore group with the VASP code and the PBE exchange-correlation functional.

The effects of Ni loading on the reaction performance are summarized in Figure 1. For both CH4 and CO2 the rate of consumption has a concave-down trend with respect to Ni loading. Shifts in XPS binding energy of the Ni 2p3/2, show a similar trend with respect to Ni loading, Figure 2. Using HAADF-STEM-EDS we were able to confirm that the Ni at low concentration resides at the interface between the MgAlOx and ZrO2 and as the loading is increased the on-top configuration is the most favorable. These observations were corroborated by the higher adsorption energy measured at the interface of the two oxides using DFT, Figure 3.





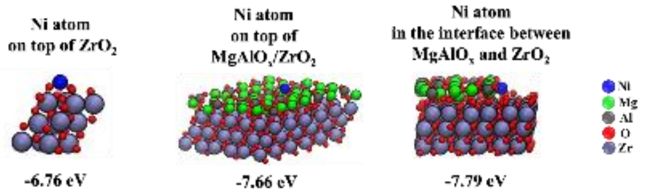


Figure 1. Effect of Ni loading on the consumption rate of methane (black square) and carbon dioxide (red circle) (normalized to the Ni amount in the reactor bed)

Figure 2. The binding energy of Ni ($2p_{3/2}$) determined by XPS for different Ni loadings in as prepared xNiO/MAZ samples, 1.1NiO/Z and 1.1NiO/MA + Z physical mixture. The most active Ni loading regime was indicated by the light blue rectangle.

Figure 3. Density functional calculations of adsorption energy for Ni atom at different locations.

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Edwar Odeh *(Poster #7, Flash Talk #3)*

Dr. Shady Farach lab, Technion

New Fast Methodology for the Development of Drug Crystals for Drug Delivery Applications

Crystalline drug formulations have recently gained attention as effective localized drug delivery systems (DDS). For instance, the crystalline form of anti-inflammatory drugs, such as Curcumin crystals, has demonstrated potential in preventing biomedical implant rejection1. These formulations offer numerous advantages as carrier-free DDS, comprising 100% drug with a minimal risk of immune response. Moreover, these formulations are chemically and physically stable. Notably, they exhibit long-term release capabilities.

Several drugs' crystallization techniques are found in the literature; among them the solvent/anti-solvent method, which enables good control of the crystallization parameters, and therefore, the crystal's size and shape. Bench solvent-antisolvent crystallization has relatively a small yield in terms of crystalline drug amount per crystallization time. This fact is considered a disadvantage when scaling from a research lab to an industrial scale.

In the presented research we aim to increase the drug crystallization yield by adding the temperature parameter as an extra driving force. This goal can be achieved by performing solvent/anti-solvent crystallization in a closed system with external radiation. Such a system is identified with heating in a faster way, more efficient, and controllable than conductive heating. Here we studied manipulating these parameters of the solvent and anti-solvent allows for optimized drug crystallization and desired properties for various drug release applications2.

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Sapir Rappoport *(Poster #8)*

Professor Yeshayahu Talmon lab, Technion

Nanostructural Characterization of Complexes of DNA with a Diblock-copolymer of Positively-charged and Neutral Blocks, and their Stability in the Presence of Blood Serum Albumin

Quaternized poly(2-(dimethylamino ethyl methacrylate)-b-poly(oligo(ethyleneglycol) methyl ether methacrylate) (QPDMAEMA-b-POEGMA) is a copolymer of a positively charged block and a non-ionic hydrophilic block. The positively charged block, QPDMAEMA, can electrostatically interact with oppositely charged polymers such as DNA, to form complexes, also known as polyplexes. These complexes are stable in aqueous solution due to the hydrophilic block, POEGMA, which provides colloidal stability and biocompatibility. Polyplexes can be used as non-viral vectors in gene therapy. The polyplexes are essential for delivering genetic material into cells because they protect the genetic material from degradation before reaching the target cells, thus increasing the transfection efficiency. In-vitro study of these polyplexes at charge ratio of 2 and 4, showed transfection efficiency of almost 50%.1 However, currently used polyplexes show a low transfection efficiency in-vivo, probably because the polyplexes are exposed to blood proteins, such as serum albumin, which cause their dissociation.

We used cryogenic transmission electron microscopy (cryo-TEM) and small-angle x-ray scattering (SAXS) to study the inner structure of QPDMAEMA-b-POEGMA and DNA complexes at different charge ratios. The results show that lamellar and hexagonal structures are formed depending on the charge ratio. Studies showed that hexagonal complexes have higher transfection efficiency than lamellar complexes.2-3 Such hexagonal complexes are shown in Fig. 1. The complexes were also examined after exposing them to bovine serum albumin (BSA). We found that BSA does not affect the complexes for seven days. That stability is essential for better design and formulation of vectors for gene therapy.

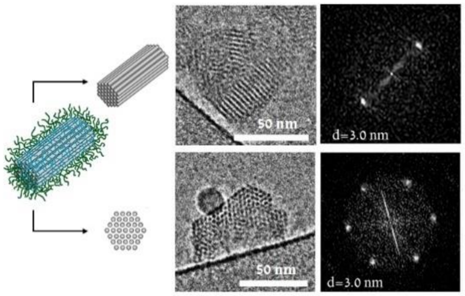

Figure2. Different projections of a hexagonal structure of QPDMAEMA-b-POEGMA and DNA complexes at CR of 10 in cryo TEM micrographs (left). The spacing is 3 nm, as shown in the Fourier transforms on the right.

References

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Gilad Sasson *(Poster #9)*

Professor Tamar Segal Peretz lab, Technion

Enhancing polymer films resistance to solvents with SIS by modifying the concentrations of the reactive functional groups

Sequential infiltration synthesis (SIS), where inorganic materials grow within polymers using atomic layer deposition chemistry, has been shown to promote polymer films resistance to solvents.1 Covalent bonds that form between the grown metal oxide and the polymer can create inorganic cross linking between chains that enhance the polymer stability in organic solvent environment.

In this study, we explore how low can you go? Can polymer film resistance to organic solvent be achieved with low concentration of functional groups that react in SIS? To that end, we have used polystyrene-random-polymethyl methacrylate (PS-b-PMMA) polymers and varied the fraction of the reactive PMMA to control the level of AlOx growth within the polymer. We monitored the AlOx growth using in-situ microgravimetry and show that while nucleation of AlOx is linearly correlated to PMMA fraction, additional AlOx growth at high cycle number occurs at higher rates at lower PMMA fractions due to the reduced diffusion of trimethyl aluminum (TMA) at high AlOx concentration of the hybrid film.

We show the relation between the enhanced solvent resistance and the functional group densities within the polymer films. Fourier transformation infrared (FTIR) spectroscopy, ellipsometry, light microscopy, and scanning electron microscopy (SEM) were used to analyze the resilience of copolymer samples in liquid and vapor toluene environments. As expected, pure PS films that lack reactive groups remained immediately dissolved by toluene, even after SIS treatment, while pure PMMA films showed excellent resistance to dissolution. High resistance to dissolution by toluene was observed also in the PS-r-PMMA films after AlOx SIS. Interestingly, PS-r-PMMA samples with as little as 9% PMMA displayed excellent resistance to dissolution after SIS. Samples with less than 9% PMMA as well as polymer blends with 9% or above PMMA in PS were susceptible to dissolution. This indicates that 10% of well dispersed AlOx within the polymer is sufficient for creating the protecting inorganic cross-linking and maintaining the films stability in organic solvents. Such strategy can be used to create stable polymers at even low concentrations of SIS reactive sites.

1. Increased Chemical Stability of Vapor-Phase Infiltrated AlOx–Poly(methyl methacrylate) Hybrid Materials Emily K. McGuinness, Collen Z. Leng, and Mark D. Losego ACS Applied Polymer Materials 2020 2 (3), 1335-1344

David Ben Shlomo *(Poster #10)*

Professor Ronen Berkovich lab, Ben-Gurion university

The effect of surface roughness and particle size on particle resuspension using a stochastic wall bounded turbulent flow model

Resuspension is a phenomenon related to the detachment of particles from a surface and their re-entrainment. This process plays an important role in environmental and industrial implications such as dispersion of hazardous particles, reactors performance, ventilation, and semi-conductor fabrication. Here we develop an up-to-date quantitative theoretical model of particle resuspension from surfaces under the influence of turbulent flow. Our modelling scheme utilizes a probabilistic approach, based on the stochastic Lagrangian theory for the description of particle resuspension and includes contact mechanics. In addition, we take into account the turbulent statistics associated with the near-wall hydrodynamical sweep-burst cycle. The model shows good agreement with experimental data, while a deviation in high friction velocities is observed. In order to describe the resuspension process more realistically, we have generalized the modelling of adhesion forces between the surface and the particle to include the effects of surface roughness, as its current formulation relates to smooth surfaces only. This study also addresses the effect of stochasticity, and tests the dependence of particle size as well as surface roughness on the resuspension process. We show that with introducing the new roughness model to the resuspension scheme, the resuspended fraction can increase by a factor of 2-3. In addition, our results emphasize that this process is governed by its stochastic nature, as the noise term dramatically increases the resuspension probabilities.

Manar Halabi *(Poster #11)*

Professor Oz Gazit lab, Technion

Evaluating the effect of fiberous ZrO_2 support on the catalytic performance of a hieriachical Ni catalyst in DRM reaction

Introduction

Methane dry reforming is a well-studied reaction that have both scientific and industrial importance. It has gained much attention in recent years for its ability to convert two greenhouse gasses, CH4 and CO2, into syngas to produce a wide range of products [1]. The best-known catalysts for DRM are based on noble metals, which are not viable for an industrial process due to their high cost. This can be overcome by using transition-metal based catalysts such as nickel (Ni). However, Ni based catalysts suffer from strong deactivation, which can be caused by carbon deposition on catalyst's surface, sintering of the Ni particles and blockage of the catalyst support pores. Recent work within the Gazit group showed that a Ni catalyst supported on a hierarchical support, composed of a thin mixed metal oxide supported on a secondary underlying metal oxide, has great potential for the promotion of DRM reaction.[4] However, the nature and extent of interactions between the Ni and the hierarchical support and how they affect DRM catalysis is still not fully understood. In this work we evaluate the effect of the underlying ZrO2 support morphology and phase on the hierachical Ni based catlayst catalytic performance.

Experimental/methodology

Nanofibers (NFs) of ZrO2 and yittrium doped ZrO2 (YSZ) were electrospun. The morphology of the NFs was characterized by high resolution scanning electron microscopy (HR-SEM), Temperature programed reduction experiments (TPR), powder X-ray diffracion (XRD) and ICP-OES. Catalytic activity was evaluated at 800 °C and atmospheric pressure in a fixed-bed quartz tubular reactor. The products were analyzed using an online GC.

Results and discussion

To induce morphological changes, the ZrO2 YSZ NFs were calcined at different temperatures perior to hierarchical catalyst preparation. Using those materials as the underlying support for Ni we prepared 6 different catlayst and tested those in DRM. It was found that supporting the Ni on the hierarchical NFs calcined at 1000 °C produced a catalyst with the highest CH4 conversion and H2/CO ratio, Figure 1. comparing these resutls to structural parameter obtained by XRD we identify chnages in crystalline phase and in grain size. Furthermore, comparing the results to particular ZrO2 we find that the NFs geometry gives advantageous performance.

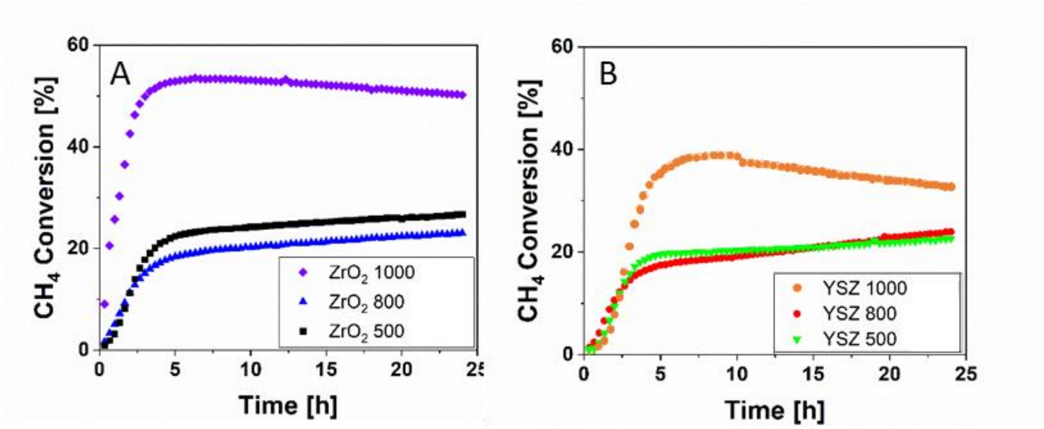

Figure 1: CH_4 conversion vs. time for catalysts prepared using A. ZrO_2 and B. YSZ, calcined at different temperatures: 500, 800 and 1000°C.

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Paz Pekerman *(Poster #12)*

Professor Havazelet Bianco-Peled lab, Technion

Triggered release device based on polydopamine's photothermal ability

A major challenge in agriculture these days is pesticide malpractice including overuse, accidental spillages, improper equipment use, and more. "Triggered release" is a potential solution to this problem, in which substances are released by interrupting the integrity of the carrying device, induced by external stimulation. This research aims to explore the feasibility of developing a new light triggered release encapsulating shell composed of shellac embedded with polydopamine nanoparticles (PDA NPs) with a trigger release mechanism based on PDA's capacity to absorb photons and convert them to thermal energy, a phenomenon often referred to as "the photothermal effect". Thus, upon light irradiation the PDA NPs can induce cavities in the encapsulated shell to promote content release. The first step in this study was to synthesize PDA nanoparticles and characterize them through dynamic light scattering (DLS), UV-Vis spectroscopy, while two types of modified shellac films containing PDA nanoparticles were fabricated and characterized by light microscopy, a high resolution scanning electron microscope (HR-SEM), fourier transform infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), puncture strength tests, and irradiation tests. The results show that PDA NPs with an average diameter of 444 nm were distributed evenly throughout the composite film’s volume. In the presence of NPs, the mechanical properties of the films were not significantly affected. FTIR analysis revealed no interaction between the different modified shellac and PDA NPs but detected oxidation products during irradiation tests. Both types of composite films based on shellac modification and a low percentage of PDA NPs ruptured rapidly upon irradiation but the modifier type and PDA NP concentration affected the thermal properties. Compounding shellac with a higher molecular weight modification or larger NP concentration shifted its melting temperature to lower values, which subsequently diminished its resistance to heat and enhanced its sensitivity to light irradiation. Thermal degradation mainly occurs in areas directly irradiated with green light, where heat is generated. In addition to potentially mitigating pesticide malpractice, the suggested light-triggered release encapsulating device might also lend itself to other applications, which could be explored further.

Eitay Shtayinberg *(Poster #13)*

Professor Yaron Paz lab, Technion

The correlation between the photoactivity of photocatalysts and the tensorial properties of the effective mass of their charge carriers

The potential of photocatalysis is well known and has been studied intensively. photocatalysts may be used for water splitting, conversion of solar energy to electricity, conversion of CO2 to fuel, and decontamination of water, air, and surfaces. When a photocatalyst absorbs a photon, generation of charge carriers occurs. The excited electron and the hole diffuse to the surface to perform redox reactions, or might recombine and annihilated. The photoactivity of a photocatalyst depends on many coupled parameters. Consequently, the large diversity in terms of efficiency among the many types of photocatalysts is far from being understood. In this study we suggest a correlation between the tensorial properties of the effective masses of the charge carriers and the photoactivity of photocatalysts. The BiOX (X= F, Cl, Br, and I) family of materials was chosen as a first model system. Micrometric single crystals of these materials were synthesized by microwave assisted synthesis. The crystals were fixed on a self-manufactured micro-electrodes made by us under clean room conditions. Two measurement modes were developed in the clean rooms, the first one is based on two parts: one functions as a fixing device and the second as the measuring electrode and as an optical window that allows the crystal to be illuminated only through a 5 µm hole. The other setup is made of one integrated device, which functions as both the measuring electrode and the fixing device. In this setup the whole crystal is illuminated. Integrating the measuring of photoinduced electrical currents at different conditions (different electrodes, different bias voltage) with the characterization of the directions in the crystals, and the calculated effective masses' tensors for the BiOX materials will, hopefully, allow us to construct a general parameter which will enable to confirm or to negate our hypothesis.

Dana Wirzeberger *(Poster #14)*

Professor Havazelet Bianco-Peled lab, Technion

The correlation between the photoactivity of photocatalysts and the tensorial properties of the effective mass of their charge carriers

Hydrogels are three-dimensional network structures able to imbibe high-water content, yet they are usually resistant to dissolution due to the cross-links between their network chains. Some applications, however, can benefit from controllable hydrogel degradation. The primary challenge lies in the development of hydrogels that are both mechanically stable and have controllable degradability under physiological conditions.
In this research, we used κ-carrageenan nano-gels (NG) that were prepared by chemical crosslinking of κ-carrageenan (C) with glutaraldehyde (GA). The new NG were added to locust bean gum (L)-κ-carrageenan (C) hydrogels to develop a new shear-thinning self-healing hydrogel. Locust bean gum and κ-carrageenan are known to have synergistic interactions, and their gelation mechanism is based on physical interactions, that are relatively weak compared to chemical interactions. The advantage of physical interactions is their reversible nature that enables the reform of crosslinking bonds after high shear stresses are applied. The addition of NG to the physically crosslinked L-C hydrogels alters the existing interactions and leads to the degradation of the hydrogels. The new hydrogels' mechanical properties were characterized by compression, swelling, and rheology testing. It was found that L-NG and L-C-NG gels displayed faster dissolution rates compare to the L-C hydrogels that didn't completely dissolve within 2 months. The modulation of C and NG concentrations offers a means to finely adjust the dissolution rate of the hydrogels. The gels' ability to dissolve in physiological conditions makes them valuable for diverse applications, including their use as sacrificial materials for wound dressing and 3D printing.

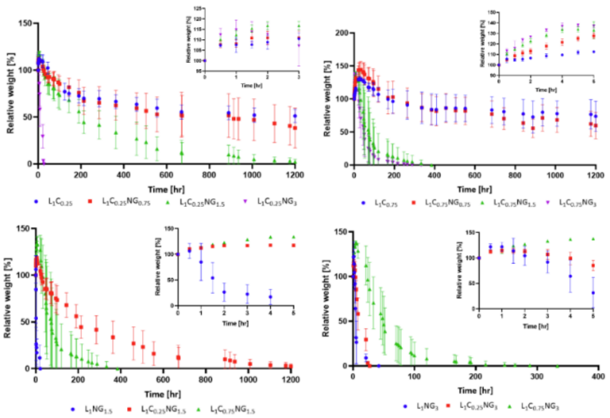

Figure 1 – The relative weights of various concentrations of L-C, L-NG, and L-C-NG hydrogels absorbed in PBS solution at 37 ℃ over 2 months.

Zihua Chen *(Poster #15)*

PhD student at Professor Dario R. Dekel lab, Technion

Water effect on the oxygen reduction reaction for anion exchange membrane fuel cells

Anion exchange membrane fuel cells (AEMFCs) is one of the most reliable, efficient technology that can potentially revolutionize energy storage and delivery; however, their commercial development is hampered by the chemical decomposition of the anion exchange membranes during operation. It requires proper water management since the oxygen reduction process consumes a lot of water, which can cause serious damage to the membrane, especially on the cathode side when there is a lack of water. Low water concentrations at the cathode in an AEMFC lead to the formation of hydroxides with low water solvation, which increases the cathode's nucleophilicity and speeds up the kinetics of degradation, even of ionomers that are typically 'stable' in strong alkaline solutions. Therefore, it is crucial to understand the role of water on oxygen reduction reaction (ORR) to get better insight into the membrane degradation mechanism. Herein, we will explore water's effect on the electrocatalysts at the cathode side, and the intrinsic mechanism of the ORR reaction in low water content environments, which might help to save the cell cathode from drying.

Shir Erez *(Poster #16, Flash Talk #4)*

Dr. Assaf Zinger lab, Technion

EPISOMES- Resected Tumor Biomimetic Nanoparticles for Personalized and Prophylactic Immunotherapies

Introduction:

One out of eight women worldwide is likely to develop breast cancer.1 Seven to eleven percent of women with early breast cancer experience a local recurrence during the first three years after treatment.2,3 Since triple-negative breast cancer (TNBC) lacks targeted therapies, why not use the tumor itself to defeat it? We fabricate patient-specific EPISOMES (epitope-presenting liposomes) using the patient's resected tumor material, serving as specific-personalized treatment and preventative care for TNBC. Resected tumor material, affected by the patient's unique microenvironment, has an enormous power to induce a specific immune response when surface-engineered into the nanovesicles.[4]

Materials and methods:

We use murine TNBC resected tumor material to fabricate patient-specific EPISOMES. Characterization of their physiochemical and biomimetic features via DLS, SDS-gel, WB, TEM, MTT, and ELISA. Examination of EPISOMES' ability to induce an immune response and cause a reduction of tumor recurrence rate, inhibit metastasis propagation, and improve mice survival.

Results and discussion:

This project's aim is to develop EPISOMES as tumor-mimicking nanoparticles (NPs) and use them as personalized and prophylactic immunotherapies.

We have established a method of incorporating murine tumor membrane proteins extracted from murine TNBC tumors into lipid-based NPs. After tumor dissociation, membrane proteins were extracted and quantified. We fabricated liposomes consisting of bare NPs as a negative control. To fabricate both types of NPs, we utilized a microfluidic-assembly protocol, adapting the NanoAssembler^{TM} benchtop system for combining cell-derived membrane proteins with lipids.

Conclusions:

Due to their ability to present patient-specific tumor cell epitopes, we hypothesize that EPISOMES can induce an immune reaction and 'educate' the immune system. Therefore, act as a preventative therapeutic for local recurrence and metastasis.

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Ester Korkus Hamal *(Poster #17)*

Professor Yachin Cohen lab, Technion

Cellulose-Coated Oil in Water Emulsions as Micro-Reactors: structure and Bio-processing of Cellulose to Biodiesel

Concerns about increasing energy demands as fossil fuel reserves are reduced and severe environment concerns encourage the development of renewable alternative raw materials for fuels. One potential alternative to petroleum-based fuels is biodiesel. Our study is part of an overall objective to convert cellulose from pretreated biomass directly to bio-diesel, using cellulose-coated emulsion particles as micro-reactors for a cascade of biochemical reactions in a "one-pot" consolidated process. Integration of cellulose-coated o/w emulsion with yeast (S. cerevisiae) cell expose a unique self-assembly configuration. Fluorescence microscope imaging and cryo-SEM imaging provide evident to an integrated structure of cellulose-coated micro-particles attached to the yeasts' surface. Moreover, we show that Cellulytic enzymes, introduced to the aqueous emulsion medium, attached to the cellulose surface coatings. This integrated structure exhibited simultaneous cellulose saccharification and fermentation to ethanol. Furthermore, it presents a "proof-of-concept" for the crucial step in this process: the ability of lipase integrated within oil-in-water emulsion particles encapsulated by natural cellulose, to catalyze transesterification of the encapsulated oil with ethanol dissolved in the aqueous medium. We examine such integrated micro-particles for generation of fatty-acid ethanol ester (FAEE) by lipase-catalyzed transesterification of castor oil at the particle core/shell interface with aqueous ethanol. The activity of lipase-catalyzed transesterification is studied by using NMR quantification of FAEE while different conditions such as oil to ethanol molar ratio, lipase concentration and temperature were examined. It is expected that the results of this study, will provide the complete transformation of cellulose to biodiesel by enzymatic hydrolysis, yeast fermentation and lipase-catalyzed transesterification, in a single emulsion-based consolidated bio-process.

Syeda Mushrifa Zahan *(Poster #18)*

Professor Dario R. Dekel lab, Technion

Investigating the performance of anion exchange membrane fuel cells with Ni-based catalyst for hydrogen oxidation reaction

Anion-exchange membrane fuel cells (AEMFCs) have made significant advancements over the past decade. Various low-cost anion exchange membranes and electrocatalysts have been synthesized, leading to improved performance. Several studies have demonstrated relatively good cell performance when employing a PGM-free cathode electrocatalysts including CoFe, CoMn, and FeNC. However, studies focusing on AEMFCs utilizing both PGM-free anode and cathode electrocatalysts are scarce. In this study, we employed a PGM-free electrocatalyst for both the anode and cathode in an AEMFC, and examined its performance under different operating conditions and design parameters. Among the very few HOR electrocatalysts that have been developed, Ni-based electrocatalysts have demonstrated remarkable ex-situ activity for the hydrogen oxidation reaction. However, their in-situ activity in a fuel cell is significantly lower due to their instability in ambient conditions. We are developing a unique activation method to increase the HOR activity of the cell. By employing this activation method, we have shown significant improvement in the catalytic activity of these electrocatalysts within an AEMFC environment. The overall results indicate an enhancement in cell performance compared to the non-activated electrocatalysts. Although the performance still lags behind PGM-based AEMFCs, we firmly believe that with proper optimization at the cell and operational level, we can substantially enhance the performance of these PGM-free AEMFCs.

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Mattan Becker *(Poster #19)*

Professor Ronen Berkovich lab, Ben-Gurion university

Mechanical study of protein-based hydrogels as high-performance materials

Hydrogels are polymeric networks that can retain a significant amount of water within their structure. Though a countless number of hydrogels are in use today in many applications, most hydrogels show limited variability in their mechanical properties, which necessitates the need for the design of new materials with enhanced and modulated mechanical properties.
This can be met in a new emerging sub-group of hydrogels is protein-based hydrogels (PBHs). These are hydrogels in which proteins are crosslinked as the building blocks in their structural network. Different from conventional hydrogels, PBHs can regulate their shape and mechanical response through changes in their internal molecular conformation. These hydrogels maintain the biochemical characteristics of their constituent molecules and show an unusual response to mechanical forces, resulting from the unfolding and extension of the folded protein domains to a few hundred-times their initial length. Therefore, PBHs show high potential in terms of rational design of hydrogels with desired mechanical properties. Here we explore the mechanical properties of such material, a Bovine Serum Albumin (BSA)-based hydrogel that we synthesized using chemical crosslinking between the protein side-chains. Utilizing nano-scale methods, namely nano-indentation using atomic force microscopy, we perform local stress-relaxation measurements of the BSA hydrogels. We observe two different time-dependent mechanisms of the BSA hydrogel's response to the application of external force: viscoelastic and poroelastic. While under ambient conditions the BSA gel complies with a viscoelastic behavior, which is related to the forced unfolding of the protein domains, and in the presence of a denaturant agent (a material that disrupts the protein structural integrity), its mechanical response is of poroelastic nature, which is associated with water migration through the newly open pores in the hydrogel network.

Yifan Li *(Poster #20)*

Professor Ofer Manor lab, Technion

Phase Separation of Oil-in-Water Emulsion with Surface Acoustic Wave

We successfully extract the oil phase out of stable oil-in-water emulsion using MHz-frequency surface acoustic waves (SAWs). We place a droplet of oil-in-water emulsion atop a piezoelectric actuator – a SAW device – which supports the formation of a surface acoustic wave near the surface of the device upon the application of weak power (1 Watt). We observe the extraction of oil film from the drop, which spread atop the SAW device, while the drop becomes increasingly transparent owing to the reduction in oil droplet concentration therein.

We successfully carried out proof-of-concept experiments with emulsion: We place 10μl drops of 10-40% oil-in-water emulsion, which are stabilized with SDS and Tween-20 (two types of surfactants), on a flat horizontal SAW device in 85% relative humidity and ambient (40-50% relative humidity) environments; see for example FIG. 1 for a 40% oil in water drop in 85% relative humidity environment. Following 6.5 minutes from the excitation of SAW in the SAW device (In addition to approximately 10 minutes in which we let the humidity equilibrate in the humidity chamber before applying SAW), we observe a 20 μm thick film of oil leave the drop and spread upon the SAW device mostly opposite to the path of the SAW. During this time, the initially opaque drop becomes continuously transparent and shrinks in size.

We find that regardless of the presence of SAW in the solid substrate (SAW device), oil droplets in the emulsion adsorb atop the free surfaces of the drop to form oil films due to the oil's low surface energy, the evaporation of water. The application of SAW extract oil off the drop by the acoutowetting phenomenon: the oil film spread due to SAW induced acoustic radiation pressure and acoustic flow. The requirement of this extraction of oil is the low surface energy of oil. Conversely, the water phase with higher surface energy will be pushed away by acoustics.

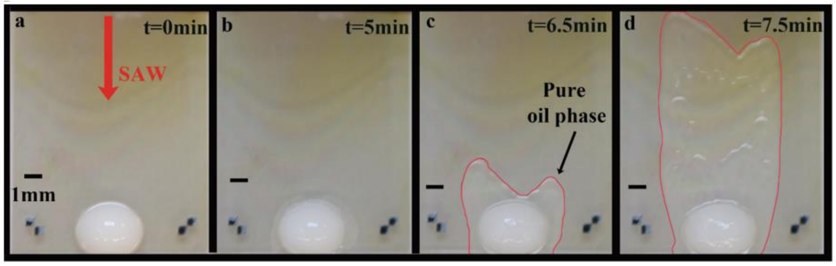


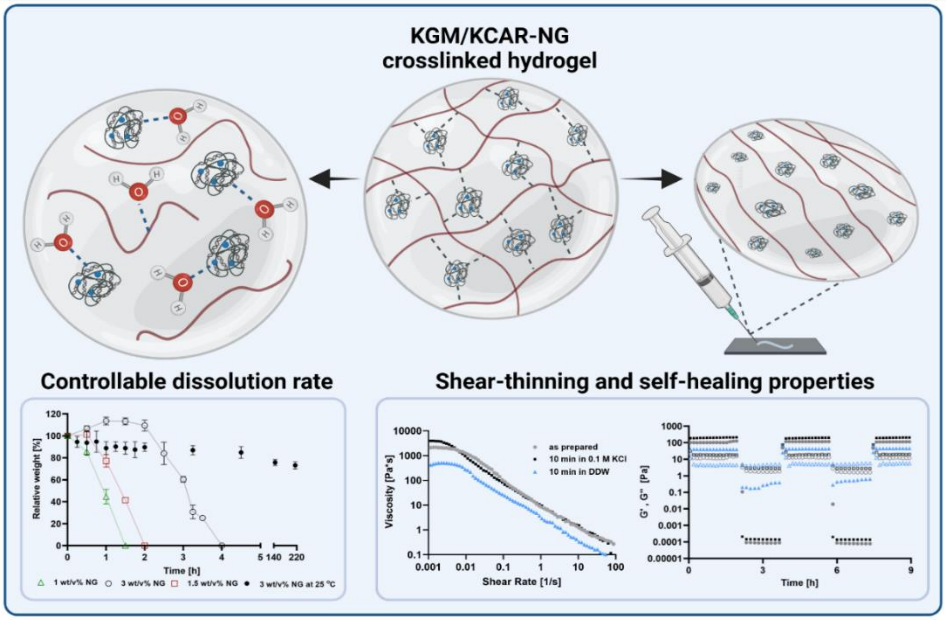
FIG. 1. Top view time laps of a sessile drop of an oil-in-water emulsion in the presence of a 20 MHz-frequency propagating surface acoustic wave (SAW) in the solid substrate (SAW device). The SAW extracts an oil film out of the drop, which continuously spreads over the substrate.

Or Peleg Evron *(Poster #21)*

Professor Havazelet Bianco-Peled, Technion

Crosslinking konjac-glucomannan with kappa-carrageenan nanogels: A step toward the design of sacrificial materials

Sacrificial materials are components used in a manufacturing process but are removed from the final product and do not remain part of it. The challenge in designing sacrificial hydrogels is to fabricate materials that are sufficiently crosslinked to be mechanically stable yet can be rapidly dissolved. My research aimed to meet this challenge by fabricating a new polymer-nanogel hydrogel based solely on hydrogen bonds between two polysaccharides. Notably, while many studies have explored hydrogel swelling behavior, only a few have focused on hydrogel dissolution. The study focused on hydrogels formed from soluble konjac-glucomannan and nanogels synthesized from kappa-carrageenan. This novel hydrogel exhibited self-healing and shear-thinning properties due to its weak physical interactions. The hydrogel dissolved simultaneously with its swelling. Changes in temperature or nanogel concentration, or the addition of potassium ions, altered the swelling and dissolution rates. The new formulation opens numerous possibilities as a potential sacrificial material for different applications since it is mechanically stable yet rapidly dissolves in physiological conditions without applying high temperatures or using chelating agents.

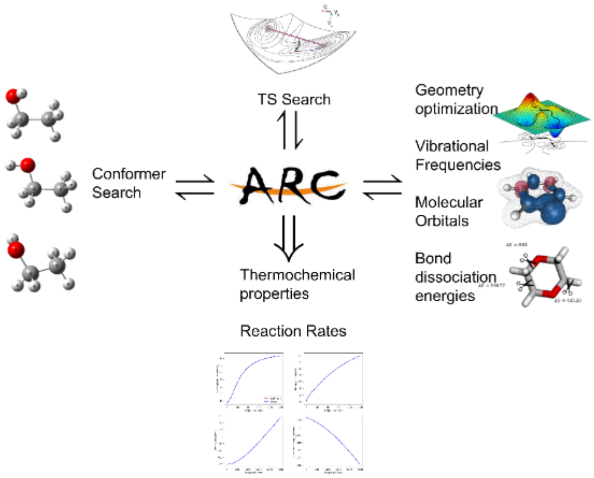


Kfir Kaplan *(Poster #22)*

Dr. Alon Grinberg Dana lab, Technion

Automated rate calculator (ARC): A tool for automated ab-inito kinetics computations

A grand challenge facing the chemical kinetics science is automated generation of predictive kinetic models to affordably and feasibly predict the reactivity of chemical systems. Often, there are orders of magnitude more parameters required for a model than available from experimental data. At the same time, computational chemistry has advanced to the stage where it has a quantitative predictive capability for reaction rate coefficients, making it an indispensable tool for the development of reliable kinetic models. Our group is developing an open-source software tool to facilitate automated computations of species thermodynamic properties and of reaction rate coefficients. The Automated Rate Calculator (ARC) software automates electronic structure calculations (DFT and wavefunction) on high performance/throughput computational servers. ARC is capable of searching for the lowest energy 3D conformer of species, transition states of reactions, and performs geometry optimizations, frequency calculations, n-dimentional torsional scans, molecular orbitals and single-point energy calculations. ARC incorporates automated troubleshooting techniques and returns thermodynamic properties for species and high-pressure limit reaction rate coefficients. It supports a wide variety of electronic structure software (Gaussian, Q-Chem, Molpro, TeraChem, Orca, and more), major cluster scheduling software (Slurm, GSE, PBS, HTCondor) and several transition state search methods (Kinbot, autotst, xtb-gsm). ARC has many advanced features, yet at its core it is simple: It accepts 2D graph representations of chemical species (i.e., SMILES, InChI), and automatically executes, tracks, and processes relevant electronic structure calculation jobs on user-defined server(s). The principal outputs of ARC are thermodynamic properties (H, S, Cp) and high-pressure limit kinetic rate coefficients of species and reactions of interest.



Lital Felzenshtein *(Poster #23)*

Professor Yaron Paz lab, Technion

Photocatalytic enantiomeric enrichment of racemic drug mixtures using ALD-assisted molecular imprinting

Enantiomeric separation, a critical process in the pharmaceutical and chemical industries, holds immense importance in the production of enantiopure drugs. Existing separation techniques such as chiral chromatography and stereoselective crystallization face limitations in terms of throughput generality, efficiency and selectivity. The research presented herein is based on a novel approach for enantiomeric separation developed by our group, via chiral molecular imprinting on a photocatalytic substrates. The proposed separation method involves adsorbing the undesired enantiomer, known as the distomer, onto the surface of a photoactive semiconductor, forming a chiral template. Following this, a non-photoactive layer is grown using atomic layer deposition (ALD) around the template, resulting in a chiral cavity. This unique configuration enables selective degradation of the distomer from a racemic solution, leading to enrichment of the desired enantiomer, known as the eutomer.

The primary objectives of this research are: (1) to study the generality of the method and its limitations by diversifying the number of separable chiral compounds, (2) to further enhance the selectivity of the separation process, and (3) to minimize the required reaction time. Here we present results with a model system comprising of a titania film as the photocatalyst, alumina as the inert layer and penicillamine as the target compound. The kinetics of the system were analysed using high-performance liquid chromatography (HPLC) to monitor the concentration of Penicillamine. The findings of this research hold significant potential in advancing the developing of an easily tunable, efficient and versatile enantiomeric separation method.

Irina Davidovich *(Poster #24)*

Professor Yeshayahu Talmon lab, Technion

Cryogenic Scanning Electron Microscopy as an Effective Tool for Nanostructural Study of Biological Systems

Diseases resulting from blood cell dysfunction, like cardiovascular diseases, account for most of the mortality in modern society.[1] Recent developments in microbiology lead to a greater understanding of cell function and structure. Techniques such as PCR, FACS, gel electrophoresis, and macromolecule blotting promote investigation of biochemical processes. However, all these techniques give numerical input, which can be interpreted by several models. It is necessary to use high-resolution (HR) imaging techniques to fully understand molecular organization within the cell and its connection to cell function and communication with its environment.

Cryo-SEM allows direct imaging of biological systems without modifying their nanostructure. The technique applicability ranges from studying the morphology of different subpopulations that may coexist in a sample, to understanding physiological processes by imaging the system at varying stages. Cryofixation with high-pressure freezing allows for maximum morphological preservation, because it captures nano-aggregates within cells at near-native conditions, while cryogenic electron microscopy provides an opportunity to study cells at high resolution as close to their native state as possible.[2]

Here, I present an application of the cryo-SEM to analyze human blood cells. It is focused on optimization of specimen preparation procedure, and working parameters for better characterization of cell morphology, ultrastructure, and cell-cell interactions.

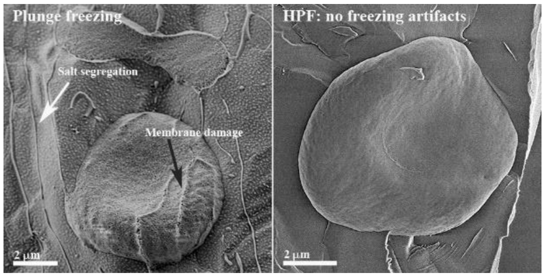


Figure1. Cryo-SEM of human erythrocytes from healthy patients prepared by two different specimen preparation methods. While specimen prepared by plunge freezing (left) suffers from several freezing artifacts, the specimen prepared by high-pressure freezing (HPF) shows excellent nanostructure preservation through vitrification.

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Sapir Lifshiz-Simon *(Poster #25, Flash Talk #5)*

Professor Yeshayahu Talmon lab, Technion

The Effect of Salts on the Nanoaggregation of SLES in Aqueous Solutions Observed by Cryo-TEM

Sodium lauryl ether sulfate (SLES) is an amphiphilic molecule widely used as an anionic surfactant in soaps, personal care, and cosmetic products.1 Minor components, like salts or fragrance molecules, are usually added to the industrial formulations of SLES-based products, and significantly affect their nanostructure and properties.2,3 SLES in aqueous solutions, with the addition of minor components, self-assemble into different nanoaggregates, such as nanometric spheroidal micelles, threadlike micelles, branched networks, and vesicles (Figure 1), depending on the concentrations of SLES and the additive. Direct imaging of SLES with commonly used salt additives can explain the nanostructural modifications affecting the macroscopic properties of the solution. This could serve as a basis for optimized formulation design of SLES-based products.

We use cryogenic transmission electron microscopy (cryo-TEM) direct imaging to study the effect of different salts on the nanostructure of SLES aqueous solutions, at different salt-to-surfactant molar ratios (X). We conduct rheological measurements to predict nanostructural changes, as the viscosity is strongly affected by the self-aggregated nanostructure of the system.2 In our study, we show the correlation between the rheological properties and the nanostructural changes of SLES with varying salt concentrations. Moreover, we present the formation of different nanostructures when different types of salts (LiCl, NaCl, KCl, and CsCl). We also demonstrate how the specimen preparation process affects the imaged nanostructures through artifact formation.4

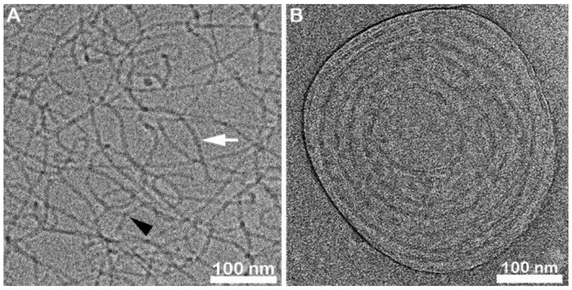

Figure 1. Cryo-TEM micrographs demonstrating the different nanostructures of 5 wt.% SLES with a salt-to-surfactant molar ratio, X, that gives the maximum zero-shear viscosity, with NaCl and KCl; (A) With NaCl, at X=10, showing networks of elongated threadlike micelles (white arrow) with several branching points (black arrowhead). (B) with KCl, at X=3.5, showing concentric multi-layered vesicle-like structures.

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Rand Shibel *(Poster #26)*

Professor Hossam Haick lab, Technion

Understanding the Signaling Pathways of Volatile Organic Compounds between Lung Cancer Cells and Monocytes

Studying cell-cell cross talk is of great importance, because it provides a rich source of information. It is especially important in cancer research since it has a major role in tumorigenesis, Proliferation, metastasis and cancer development. There are several chemical mechanisms by which cancer cells and tumor microenvironment can communicate through. It is widely noticed that systemic inflammation plays an important role in the development and progression of many solid tumors. Proinflammatory cytokines and circulating immune inflammatory cells such as neutrophils, platelets, and lymphocytes mediate this axis. In this endeavor, Volatile Organic Compounds (VOCs) are considered a new class of immune-modulatory signaling molecules with the potential advantage that they can diffuse and transfer to long distances. Nevertheless, this category of molecule has not been investigated as signal transductors.

The overall objective of the current study is to investigate the role VOCs play in communication between lung cancer cells and immune cells and their means of transportation.

Our hypothesis is that VOCs might need a carrier in order to circulate the blood stream, since some VOCs are hydrophobic molecules. Extracellular Vesicles are known to mediate cell-cell communication between primary tumor cells and the microenvironment.

To get an initial idea regarding the possibility that VOCs are transferred through Exosomes from cancer cells to other destinated cells. Exosomes were Extracted by an Ultracentrifugation from the cell culture medium of the monocytes, grown under the same head space of cancer cells. Cryogenic electron microscopy was utilized to visualize the exosomes, for detection and characterization purposes. To validate the previous finding, a particle size distribution curve was preformed, which demonstrates consistent with the size range of exosomes. To identify the most significant differentially expressed VOCs emitted from the cell culture's exosomes, cell cultures headspaces were sampled, after cells culturing period and analyzed by a GC-MS.

Shakked Regev *(Poster #27)*

Professor Yaron Paz lab, Technion

ALD on Photocatalytic Particles

Atomic Layer Deposition (ALD) is a well-established technique for the growth of ultrathin, conformal and high-aspect ratio films. It is used for the growth of a wide variety of coatings through a sequential, self-limiting reaction between two precursors introduced in an alternating fashion (A-B-A-B). This method has found use in photocatalysis as well, both for the growth of the photocatalytic material itself, and its coating with other materials for hybrid functionalities, such as ultrathin inert layers used for corrosion resistance or molecular imprinting. However, a considerable challenge arises from these applications, due to the reliance of photocatalytic mechanisms on surface active sites, pushing towards the use of powder catalysts. These are challenging to coat using ALD, as during each precursor pulse, only a portion of the catalyst's surface will be available to react. Moreover, surface chemistry plays an important role in the conformity and adhesion of ALD layers, especially for coatings in the ultrathin regime, with, for example, non-oxide materials comprising of a large portion of photocatalytic materials of interest, but are significantly harder to coat with ALD.

In this work, ultrathin coatings of Al_2O_3 were deposited on photocatalytic powders of TiO_2 and BiOCl. Powders were coated in a tailor-made ALD manufactured by VST, with a powder chamber designed to allow gases to fluidize the coated particles with minimal powder loss. The particles were also exposed to several sequential pulses of each precursor in each cycle (A-A-A-B-B-B), termed subcycles, allowing fluidization and mixing of the particles, and an auxiliary valve was used to close of the reaction chamber after each pulse, to allow for higher adsorption dwell time and increased coverage. The effects of the number of cycles, number of subcycles and dwell time were tested, with the coating characterised using EDS and kinetic measurements of the photocatalytic degradation of Rhodamine B. Since Rhodamine B is a hydrophobic molecule, it tends to adsorb better on alumina than on the photocatalyst itself, hence any pinholes in the ALD coating will result in an adsorb and shuttle mechanism and increased degradation rates, while pinhole-free coatings result in decreased rates.

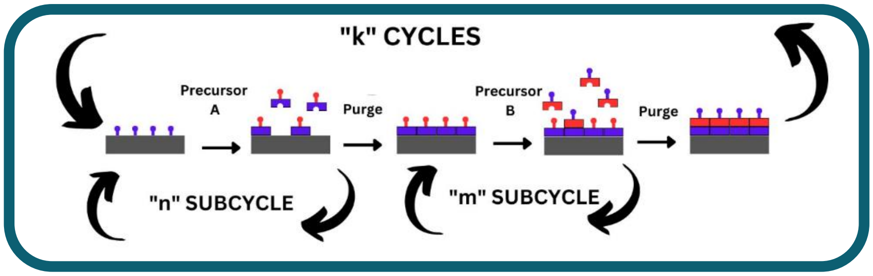


Figure 1. A schematic representation of an ALD process comprising of precursor cycles and subcycles, with repeats of each precursor.

Nagham Rashed *(Poster #28)*

Dr. Shady Farach lab, Technion

Synthesis and Characterization of Multifunctional Acrylate-based UV Polymerizable Bio-Resin for 3d Bio-Printing Application with Antimicrobial Properties and for Controlled Release of Bioactive Substances

Three-dimensional (3D) printing, also known as additive manufacturing (AM), is where new materials are continually added to the final printed object. Typically, to 3D-print a design, the design must be drawn in a CAD software package such as autodesk inventor, solidworks, etc. Our research focuses on photopolymerizable materials, including multifunctional monomers and prepolymers. Photopolymers are considered one of the leading materials used in 3D printing and are specifically widely in use for DLP and SLA. Photopolymers are light-sensitive polymeric materials, which change their physical or chemical properties when exposed to light sources, which initiates a reaction and changes the chemical and mechanical properties of photopolymers.

Antimicrobial preservatives are widely used in the formulation of pharmaceutical creams and ointments as well as in cosmetics and toiletries. A special class of preservatives is known as formaldehyde-releasing agents, and they may exhibit their action by releasing formaldehyde or by action of the parent chemical structure of the compounds. Here we aim to develop a multifunctional acrylate-based UV polymerizable bio-Resin based on small molecules for 3d bio-Printing applications with antimicrobial properties where the correlation between chemical structure and printability is intensively studied. These multifunctional polymers were studied also for degradability and for controlled release applications.

Reem Hogerat *(Poster #29, Flash Talk #6)*

Dr. Shady Farach lab, Technion

Biodegradable Polyesters-based Green Renewable Materials for Controlled Drug Delivery Applications

Biodegradable polymers based renewable sources are widely considered drug delivery systems due to their low toxicity, safety, degradability, stability, and renewable nature. These biopolymers are extracted from various natural resources. Polymers of a carbohydrate origin have been prominent in drug delivery through various routes. Here; we are focusing on sugar derivatives that are of a carbohydrate origin and react with various modified and unmodified short diacids and study their suitability for drug delivery application. We hypothesize that utilizing sugar derivatives as a component in polymers' synthesis would result in various polymers with tunable properties and degradation profiles, which can be utilized for drug delivery applications of hydrophilic and hydrophobic drug molecules. For this, it is our goal to synthesize and characterize different novel biodegradable polyesters prepared from renewable resources of sugar derivatives and diacids in different conditions and to allow post-polymerization modifications and varied drug loadings. Here we studied the correlation between structure and properties as well as degradation and drug release using drug models.

Leah Shimonov *(Flash Talk #7)*

Professor Joseph Kost lab, Ben-Gurion university

Topical Delivery of High Molecular Weight Hyaluronic Acid Using Polysaccharide Carrier and Ultrasound Application

One of the key molecules involved in skin aging process is hyaluronic acid (HA), a glycosaminoglycan long unbranched polysaccharide responsible for skin moisturizing and collagen production in the extracellular matrix. HA is found at the highest concentration in the dermis (the lowermost layer of skin). Due to its highly anionic properties, it can strongly bind water molecules to provide structural support and skin volume. Also, naked HA has a relatively short half-life of less than a day in the skin due to enzymatic degradation. Today there is extensive use of hyaluronic acid injections for anti-aging treatments that have numerous disadvantages, which can range from mild symptoms such as localized pain or swelling to more serious problems such as an injury due to injections into blood vessels in the skin. There is yet an unmet need for a non-invasive means for topical delivery of high molecular weight (HMW) HA. Therefore, this study aims to assess the application of ultrasound (US) in combination with quaternized starch (Q-starch) as a carrier for the non-invasive delivery of HMW HA into the dermis, presenting increased HA stability and retention time in the skin.

Ravit Arbel *(Flash Talk #8)*

Professor Avi Schroeder lab, Technion

NIR Photocatalytic QDs for Nanomedicine Applications

Electric precise nanomedicine is an emerging field, that aims to treat and relieve medical conditions by controlling and manipulating biological processes in the human body. An electric potential can affect cell signaling pathways, stimulate and initiate various cell activities, catalyze biological reactions, generate programmed cell death, and relieve pain. Controlling those functions will have a huge potential in controlling tissues, organs, and full body conditions. The long-term goal is to develop a bio-electric efficient treatment with simple and minimally invasive procedures, high spatial and temporal precision, and low side effects.

Photocatalytic nanoparticles, which generate electrons and charge transfer under light illumination, are a promising class of materials for charge transfer based precise nanomedicine since, they allow good cell uptake, blood circulation, and minimally invasive injection. However, generating photocatalysis activity in biological environments is challenging since many of the photocatalytic nanoparticles are containing toxic heavy metals, unstable or insoluble in an aqueous solution, or require toxic ultraviolet (UV) light, with bad tissue penetration for activation.

Here we developed and characterized biocompatible Ag2S Ni-doped quantum dots (QDs) which are activated by near-infrared (NIR) light in the biological window which penetrates tissues well and is not toxic. The NIR light activation assigns the system with a stimuli-responsive on-off switch mechanism activation and spatiotemporal control. The QDs are stable in water and have photocatalytic activity in biological environments. An In vitro study aimed to investigate the capabilities within a living system showed stability and promising photocatalytic activity of the QDs. This study highlights essential steps for photocatalytic nanoparticles to break into the precision electronic nanomedicine field as a therapeutic innovative approach for electric bio manipulations in the body.

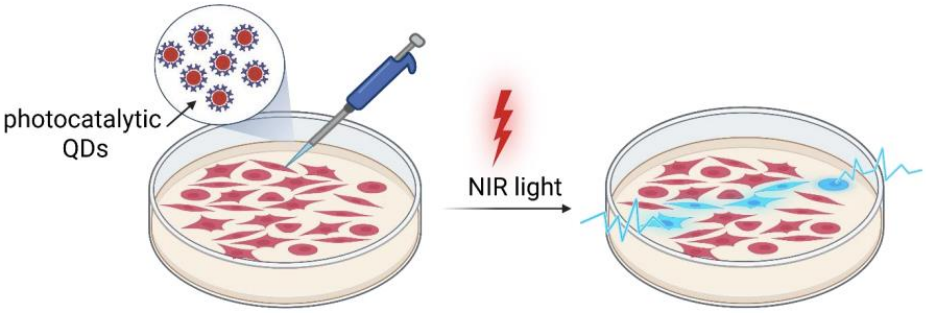


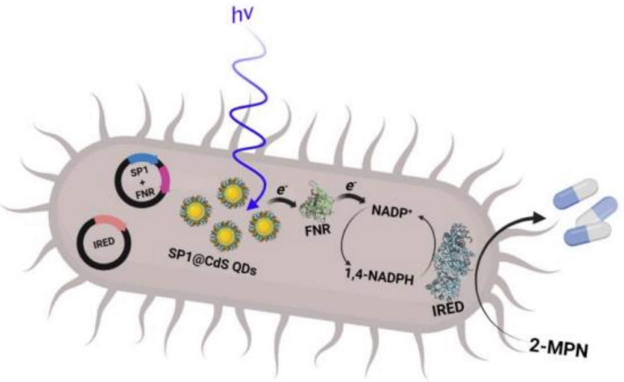
Figure 1. Illustration of NIR light activated photocatalytic QDs for cell stimulation. Created with BioRender.com

Oren Bachar *(Flash Talk #9)*

Professor Omer Yehezkeli lab, Technion

Living Cells with Biosynthesized Nanomaterials – Can We Generate a Cyborg Organism?

We suggest a new concept for a self-sustained biotic-abiotic cyborg organism, which comprises a biological system with an add-on nano-based organelle. In this whole-cell biohybrid system, I plan to use the distinctive structure of stable protein 1 (SP1) for the biosynthesis of various size-constrained inorganic nanomaterials in living systems. These nanomaterials are optically and electronically active NPs that can be utilized for various catalytic or photocatalytic processes [1,2]. Here we show the biosynthesis of CdS NPs stabilized by a predesigned SP1 variant at ambient conditions.3 The size controlled crystalline NPs were utilized for NADPH regeneration which was subsequently used for the activation of the imine reductase (IRED) enzyme (as depicted in the scheme). The system enabled the generation a vital product for the pharmaceutical industry. We extended this platform to a fully integrated photocatalytic NADPH regeneration system in a whole living bacterium. In our recent results, we demonstrate the exclusive ability of SP1-expressing cells to biosynthesize photo-catalytically active CdS NPs. Finally, we demonstrate the use of the generated photo-active NPs in activating a solar driven cascade within a whole organism to produce fine chemicals. We attempt to investigate this new concept in a broader evolutionary perspective. The incorporation of biosynthetic capabilities of nanomaterials in living cells could allow new properties not only for the enhancement of a single enzymatic reaction, but also in the level of the whole organism.



References:

[1] O. Bachar et al., Chem. Commun., 56, 11211–14, 2020.

[2] O. Bachar et al., COBIOT, 81:102943, 2023.

[3] O. Bachar et al., Angew. Chem. Int. Ed., 61, e202202457, 2022.

Wisal Khalaily *(Flash Talk #10)*

Professor Yoed Tsur lab, Technion

Studying the Effect of Operating Conditions and NO_2 Cathode Contamination on PEM Fuel Cells Using Distribution of Relaxation Times Analysis

A polymer electrolyte membrane fuel cell (PEMFC) is a highly advantageous and environmentally friendly energy converter that operates at low temperatures (70-100 °C), boasts high power density (~1.4 kW/kg), has high electrical efficiency (40-60%), and operates quietly. Despite these benefits, commercializing PEMFCs remains a challenge due to cost and durability concerns. Impurities in feed streams are a significant factor contributing to durability issues, and as a result, the development of PEMFC technology requires intensive research and development efforts.

EIS has proven to be an essential diagnostic tool in PEMFC research. A significant advantage of EIS is its capability to assess the total impedance from different components or processes within a PEMFC. However, reliable analysis of EIS data is crucial to correctly identify contributors. To achieve this, we employed the Impedance Spectroscopy Genetic Programming (ISGP) technique as an analysis tool.

In this research, PEMFCs operated under high levels of NO_2 cathode contamination while conducting in-operando EIS measurements. The data were analyzed using ISGP, and the findings highlighted the influence of NO_2 cathode contamination on the primary processes within a fuel cell. NO_2 appeared to be harmful to the PEMFC at high temperatures. The electrochemical process that is related to the permanent degradation is the oxygen mass transfer. Furthermore, a method to partially mitigate the damage resulting from NO_2 contamination is also proposed, and it appeared to be helpful at low temperatures.

Nathan Blank *(Poster #30)*

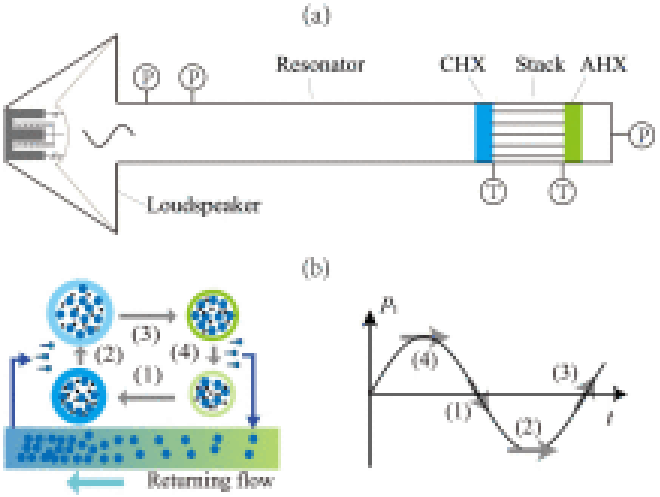
Professor Guy Ramon lab, Ben-Gurion university

An acoustic heat pump based on phase change

Thermoacoustic cooling is a novel cooling method, that employs sound waves as the driving force. It has the advantages of reliability, simplicity, and utilization of benign working gases that are not harmful to the environment.

Recently, we have shown that the performance of thermoacoustic coolers can be greatly improved by introduction of various chemical reactions into the acoustic cycle. Specifically, evaporation, condensation and sorption have been shown to be advantageous.

In this talk, the physical mechanisms behind classical and phase-change thermoacoustic cooling are described, as well as a simplified 1D model that is used to analyze thermoacoustic devices and predict performance.



Margarita Antonenko *(Poster #31)*

Professor Yachin Cohen lab, Technion

From cellulose to poly(lactic acid) by emulsion-based consolidated bioprocessing

Poly(lactic acid) (PLA) is a biodegradable polymer that can be fabricated from natural resources, hence termed as “bioplastic”. Ligno-cellulosic biomass is a renewable alternative resource of raw materials for fuels and chemicals. The major drawback for society’s adoption of these alternative materials is the high cost of the processing required for their effective utilization. This project aims to develop a “one-pot” process for conversion of cellulose from pretreated biomass directly to PLA using cellulose-coated emulsion particles as micro-reactors for a cascade of biochemical reactions. In this research emulsion microparticles are formed by homogenizing a suspension of cellulose hydrogel particles with a suitable PLA solvent. The microgels are obtained by regenerating cellulose solution in aqueous alkali, which is a relatively non-hazardous and is readily recycled. The emulsion particles have a unique structure of an inner hydrophobic core covered by a shell of aqueous cellulose hydrogel encased in an outer continuous shell of amorphous cellulose. Micro-organisms (yeasts and/or bacteria) are integrated with the cellulose-coated emulsion particles containing cellulytic enzymes attached to their outer cellulose shell and lactic acid (LA)-polymerizing enzymes (lipase) incorporated at the inner core’s oil/water interface. The hypothesis is that as the micro-organisms are surrounded by the microparticles, this can provide an effective cascade of consolidated bioprocesses: saccharification of the cellulose coating to glucose, which is fermented to LA, and its polymerization by lipase at the inner core/shell interface. PLA accumulation in the particles’ solvent core can be readily separated. Current results demonstrate the particles structure and their integration with yeasts. Preliminary results of LA polymerization by lipase incorporated in the microparticles is presented.

Itzhak I. Maor *(Poster #32, Flash talk #11)*

Professor Gideon Grader lab, Technion

High thermoelectric performance of textured $Ca_3Co_{4-x}O_{9+\delta}$ ceramics via electrospun nanoribbons

The rising demand for global energy is hampered by low utilization efficiency, since more than half of it is lost as waste heat (e.g., in industry and transportation engines). In light of the increasing use of electricity, conversion of this waste heat to electricity could be beneficial. Such a thermoelectric (TE) energy harvesting can be performed using solid state devices, that enable direct generation of electric power when exposed to a heat source. Those TE devices are composed of legs of p-and n-type semiconducting, TE materials, whose thermoelectric performance must be improved to achieve better energy conversion efficiency and/or higher power output, depending on application requirements and available heat source.

Calcium cobaltite $Ca_3Co_{4-x}O_{9+\delta}$ (CCO) is a promising p-type thermoelectric (TE) material for high-temperature applications in air. The grains of the material exhibit strong anisotropic properties, making texturing and nanostructuring mostly favored to improve thermoelectric performance. On the one hand multitude of interfaces are needed within the bulk material to create reflecting surfaces that can lower the thermal conductivity. On the other hand, low residual porosity is needed to improve the contact between grains and raise the electrical conductivity. In the present work, we electrospun CCO fibers with 100% flat cross sections in a stacked, compact form. We then grew the grains within the nanoribbons in the plane of the fibers. Finally, we assembled the nanoribbons into a textured ceramic (see Figure 1) that features simultaneously a high electrical conductivity of 177 $S \cdot cm^{-1}$ and an immensely enhanced Seebeck coefficient of 200 $\mu V \cdot K^{-1}$ at 1073 K. The power factor of 4.68 $\mu W \cdot cm^{-1}\ K^{-2}$ at 1073 K in air surpasses all previous CCO TE performances of nanofiber ceramics by a factor of two. Given our relatively high power factor combined with low thermal conductivity, we obtained a relatively large figure-of-merit of 0.3 at 873 K in air for the textured nanoribbon ceramic.

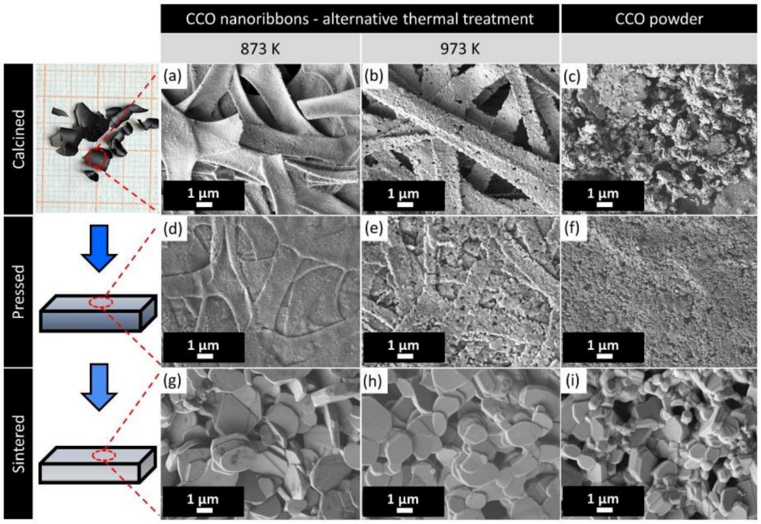


Figure 1. SEM surface micrographs of CCO nanoribbon mats calcined at (a) 873 K and (b) 973 K, (c) CCO reference powder; Calcined bodies composed of cold-pressed CCO nanoribbons mats calcined at (d) 873 K, (e) 973 K and (f) CCO powder body; Nanoribbon ceramics of CCO nanoribbon mats pre-calcined at (g) 873 K, (h) 973 K and (i) CCO powder ceramic.

Sivan Barash Shahar *(Poster #33, Flash talk #12)*

Dr. Assaf Zinger lab, Technion

Developing Novel Treatment for Rett Syndrome Using mRNA-MECP2 Encapsulated in Biomimetic Lipid Nanoparticles

Introduction: There is no cure for Rett syndrome (RTT). RTT is a complex female neurological disorder, resulting from a mutation in the MECP2 gene, encodes a key brain protein. These days, mRNA therapy has emerged as a promising class of drugs for addressing various genetic disorders from their source, particularly rare and incurable diseases such as Rett syndrome (RTT), by restoring functional protein levels. To optimize gene therapy approaches, delivery mechanisms must be improved, where lipid nanoparticles (LNPs) encapsulating mRNA molecules hold great potential as an effective and safe delivery tool. Furthermore, integrating neuron-derived membrane proteins into the LNP surface can mimic the natural cells' communication mechanisms, increasing its therapeutic effect on neurological disorders. Herein, we developed a new class of mRNA-LNPs incorporating neuron membrane proteins and evaluated their functional ability to deliver and target mRNA payloads within neurons, in vitro and in vivo, as a proof-of-concept for MECP2 gene delivery system.

Methods: The mRNA-LNPs (Poly-A, EGFP, Luciferase) were fabricated using the NanoAssemblrTM microfluidic bottom-up approach. We characterized LNPs physicochemical properties with Dynamic Light Scattering and measured mRNA encapsulation efficiency. Subsequently, we used a fluorescent microscope to observe the association of LNPs and mRNA expression within neurons. Finally, we administered mRNA-LNPs locally to mice brains, evaluating biodistribution and mRNA expression using an in vivo imaging system, and assessed LNPs specific neuron targeting of sectioned brains using confocal microscopy.

Results: We were able to synthesize stable mRNA-LNPs combined with neuron membrane proteins and encapsulate effectively (>85%) mRNA payloads. Both in vitro and in vivo experiments demonstrated non-toxic mRNA-LNPs association with neurons resulting in notable GFP/Luciferase expression. These outcomes provide valuable preliminary evidence for a new targeted delivery platform to treat neurological diseases with genetic therapeutics cargos.

Conclusions: We anticipate our mRNA delivery tool to provide a powerful approach for the specific delivery of needed therapeutic cargoes to neurons to treat genetic neurological diseases, which can be particularly applied as a novel method to treat or improve rare disorders symptoms such as RTT.