**From Lab-On-a-Chip to Lab-On-a-Particle Electrically-Powered Platforms**

Prof. Gilad Yossifon

*Faculty of Mechanical Engineering, Micro- and Nanofluidics Laboratory, Technion – Israel Institute of Technology, Haifa 32000, Israel*

Towards lab-on-a-particle platforms we suggest using mobile engineered active (“self-propelling”) carriers to revolutionize diagnostic testing and sample analysis; with advantages of the traditional lab-on-a-chip (e.g. portability, efficiency) but overcoming current challenges (e.g. complexity, predetermined design). Our novel generic active carrier, acting as a mobile floating microelectrode, uses a single externally applied electric/optical field to selectively trap, transport and deliver user-specified payload(s). Our unified solution is simpler and more robust than current systems where carrier propulsion and cargo manipulation are controlled by separate mechanisms. Moreover, current cargo loading requires specific and predefined targets and release of the cargo (if possible) is complicated. Our recent work [1] demonstrated that using dielectrophoresis (DEP), a frequency-dependent mechanism can selectively load and release the transported cargo. This offers a label-free method to generically, selectively and dynamically manipulate (load and release) a broad range of organic/inorganic matter [2]. Adding directed motion via magnetic stirring enables to develop these active particles into in-vitro assays with single cell precision and building blocks for bottom-up fabrication. Besides the local electric field gradient intensification essential for DEP, an important novelty of our mobile microelectrodes is also the strong ***local*** electric field intensification induced by the inherent small gap between the metallic patches of the active particle and the conductive substrate underneath. This property was recently exploited by us [3] to demonstrate a novel method of local and targeted (i.e. only those cells that are in contact with the active particle) electroporation of bacteria as well as micromotor based biosensing.

1. Boymelgreen, T. Balli, T. Miloh and G. Yossifon, Mobile Microelectrodes: Unified Label-Free Selective Cargo Transport by Active Colloids, Nature Communications 9:760 (2018).
2. X. Huo, Y. Wu, A. Boymelgreen and G. Yossifon, Analysis of cargo loading modes and capacity of an electrically-powered active carrier, Langmuir.
3. Y. Wu, A. Fu, and G. Yossifon, Active Particles as Mobile Microelectrodes for Selective Bacteria Electroporation and Transport, Science Advances (2020).
4. S. Park and G. Yossifon, Micromotor-Based Biosensing Using Label-Free and Directed Transport of Functionalized Beads, ACS Sensors (accepted).