

Prof. Hossam Haick

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Hossam Haick (40 years old), an expert in the field of nanotechnology and non-invasive disease diagnosis, is a **Full Professor** and the **F.M.W. Academic Chair** in the Department of Chemical Engineering and the Russell Berrie Nanotechnology Institute at the Technion – Israel Institute of Technology.

In 2007, Hossam appeared on the list of 50 leading Israelis and four saluted Israeli scientists. In 2008, Hossam appeared on the MIT *Technology Review* list of **35 leading young scientists in the world**. In 2010, he was named one of the 10 Most Promising Young Israeli Scientists and one of the Young Israelis of the Year. In 2013, he received a listing of the "50 Sharpest Israeli Minds" by the Marker. In 2015 he received a listing as the **world's top-100 influential innovators in the Digital Technology** for 2015 by Nominet Trust (London, UK). In 2016, he received the listing of the **world's top-100 influential scientists in the Medical Field** for 2016 by the GOOD Magazine (Los Angeles, USA).

Hossam excels in all aspects of academic work—research and development, teaching, commercialization, as well as in voluntary service to the larger society. Prof. Haick has proven capabilities for **high-quality basic science discoveries**, for example: detection of volatile biomarkers that are linked with disease states and understanding the associated biochemical mechanisms; **translational research and development** such as tailor-made non-invasive sensors that detect disease-related volatile biomarkers; and **commercialization of the developed technologies** - a few of his patents have already been licensed to large companies and three SMEs have been established, as further described.

On the basic science front, Prof. Haick adapted novel spectroscopy and spectrometry techniques and carried out in-vivo, in-vitro, and ex-vivo experiments to gain new understanding about the volatile biomarkers. In his early discoveries, he showed, for the first time ever, that **cancer has a unique (volatile) molecular print through exhaled breath samples**. Later, Prof. Haick and his group showed that **each disease has its own unique volatile molecular print** and, therefore, **the presence of one cancer would not screen out others – a prerequisite for developing new generation(s) of biomedical devices for personalized screening, diagnosis, and future screening of various diseases in a noninvasive, inexpensive and portable manner**. These results serve as the **main milestone towards formal recognition of a new field of biomarkers, so-called "volatolomics" (the omics of volatile biomarkers)**.

To translate these results from basic science to **point-of-care** reality, Prof. Haick's group has developed and patented (~36 patents) a new technology termed **Artificially Intelligent Nanoarray** that allows diagnosis of more than 23 disease states through exhaled breath using a non-invasive, inexpensive (~2 USD/examination), fast (two to three minutes) method. Added to this, the artificially intelligent nanoarray is easily portable (2 cm x 3 cm x 0.2 cm) and affordable in developing countries as well as in developed countries. The chief strength of this technology is implementation of nanomaterial array on which the artificially intelligent nanoarray is based. Indeed, Prof. Haick and his group were able to find a unique balance of diversity and commonality in the different (functionalized) nanomaterial systems they fabricated to enable a response that is amenable for analysis in terms that mimic the olfactory system. Altogether, Prof. Haick and his team were able to engineer analyzer devices from the fabricated nanomaterial-based sensor arrays which have been put to **practical evaluation in more than two dozen hospitals worldwide**. In these evaluations, **blind experiments** have shown most impressive results of the nanotechnology-based nanoarray in **real clinical settings**. The nanoarray-based (breath) test was successfully implemented for various types of cancers, chronic and acute kidney disease, hepatic disease, pulmonary arterial hypertension and more. For many disease states, the technology developed was able to discriminate even between sub-categories of a specific disease as well as between volatile organic compounds that are associated with genetic mutations of important disease states (P53, K-RAS, EGFR, and ALK), aspects that aid in providing personalized diagnosis and help tailor personalized treatment.

As a complementary tool for the artificially intelligent nanoarray technology, Prof. Haick and his team have developed and characterized sensing smart patches that imitate the human skin, in the sense they can simultaneously feel pressure (or touch), humidity, temperature and chemical analytes. These smart patches, which are **self-healable** (i.e., heal / repair the

electronic / chemical / mechanical properties after a cut or scratch in an autonomic manner) can equip computers, robots and smart objects with the sense of touch, enabling them to “feel” their surroundings. The patented technology has very high tactile resolution and fast readout times that match, and even exceed, human fingertip touch sensation. In addition, compared to other common technologies, the patches require smaller data readout volumes (at least one order of magnitude smaller than currently available patches), low power consumption, low operating voltage (~1 volt) and can be fabricated using low-cost printed electronic manufacturing processes. **These features place this technology at the forefront of today's tactile smart patch market and therefore open new technological and business opportunities**, such as touch-sensitive robots and medical devices, prosthetic limbs with tactile feedback, as well as, wearable smart patches for sports and rehabilitation. The promising features of this technology for health monitoring were the reason for the collaboration between Prof. Haick and the **Bill & Melinda Gates Foundation**, with the support of the **World Health Organization (WHO)**, to further develop it to detect infection diseases in people who live on less than 1 USD/day and have no infrastructure (water or electricity) in their hometowns.

Relying on these funds and on his creativity and motivation, Prof. Haick has an excellent record, highlighted as follows:

- 1) **Publications:** Since he joined the Technion in 2006, Prof. Haick and his colleagues have compiled more than 170 publications in top-level journals in the field of nanotechnology, and advanced/applied materials/chemistry. Though he was educated as an engineer, Prof. Haick has been publishing his works in leading clinical journals as well. Advances in basic science from Prof. Haick's research have led to the production of five book chapters in books of leading publishers.
- 2) **National and International Recognition:** Prof. Haick received a listing in the **world's 35 leading young scientists** for 2008 in MIT's scientific journal *Technology Review*, the **"50 Sharpest Israeli Minds "** by *The Marker* (2013), the **world's top-100 influential innovators in the Digital Technology** for 2015 by *Nominet Trust* (London, UK), and the **world's top-100 influential scientists in the Medical Field** for 2016 by the *GOOD Magazine* (Los Angeles, USA). Additionally, he has received more than 52 prizes and honors, including: a Knight of the Order of Academic Palms (Chevalier dans l'Ordres des Palmes Académiques)¹, the Horev Chair for Leaders in Science and Technology, the Halevy Award for Innovative Applied Engineering, the LERMIT's International Chair of Therapeutic Innovation, the Tenne Prize for Nanoscale Sciences, the Innovation and Entrepreneurship Prize in Chemical Engineering, the OXYGEN Prize (Paris, France), the Bergmann Award for Excellent Scientists, the Herschel Rich Innovation Award, and more. In January 2013, the Technion and INSERM (National Institute of Health Research, France) announced signing an **academic agreement** between the laboratories of Hossam Haick in the Technion and the Respiratory Diseases Department, led by Professor Marc Humbert, after they were awarded the very competitive LIA (International Associate Laboratory) funding. Besides these achievements, Prof. Haick has **founded** and is currently **coordinating** three consortiums:
 - **FP-7 consortium (LCAOS; 2011–2015):** This consortium includes 4 academic partners, 2 hospitals, and 3 SMEs, which was ended with stand-alone, on-line system for cancer detection that has been put in more 11 hospitals (till now) in several countries.
 - **EuroNanoMed consortium (Volgacore; 2014–2017):** This consortium includes 5 academic partners, 3 hospitals, and 2 SMEs. Currently, more than 8 European hospitals use the technology developed in this project by Prof. Haick and his team and collaborators for detection of gastric diseases, on more than 8,000 patients.
 - **Horizon2020 ICT consortium (SniffPhone; 2015-2019):** This consortium includes 4 academic partners, 2 hospitals, 3 SMEs, and one big company (SIEMENS AG Corporate Technology; Muenchen, Germany). **This project was selected recently as one of the MOST influential projects in the world for 2015 by the Nominate Trust (London, UK).**
- 3) **Technology Transfer:** the nanotechnology-based tools of Prof. Haick and his colleagues have led to the production of more than 36 patents and patent applications. His technologies have received several top rankings, by several foreign agencies. Some of the patents were licensed to a worldwide leader international company in disease management; **OlfaGurad** (a new startup company that is located in Israel); and **BreathTec** (an established SME

¹ Established in 1808 by Napoleon Bonaparte, the prestigious Academic Palms is the oldest extant civilian accolade awarded by the French Government. The order was created to honor top, eminent academics and educators. The knights of this order wear a medallion on a ribbon on their left breast.

that is located in Canada / US). In April 2014, Prof. Haick co-founded, together with two of his previous researchers, a new **start-up company (NanoVation – S.G. LTD.)** for the commercialization of advanced non-invasive technology for monitoring the vital signs. In 2016, Prof. Haick co-founded, together with two of his previous Ph.D students, another **start-up company (FeelIT LTD.)** for the commercialization of unpixelated (analog) touch-sensitive flexible surfaces that has very high tactile resolution and fast readout times to match, and even exceed, human fingertip touch sensation.

- 4) **Teaching:** Considering the schedule of a busy researcher, one may worry whether he also has time for teaching, but there is no need for concern on this point, since Hossam Haick has regularly been awarded the Technion's Excellence Award in Teaching (top 4%) as well as the prestigious "Yanai Prize for Academic Excellence", which is given for exceptional and significant contribution in teaching and academic education. Recently, Prof. Haick designed and developed the first massive open online course (MOOC) in the Technion and he is the first person worldwide to do this in two languages (<https://www.coursera.org/course/nanosensors>). This MOOC focuses on the fields of nanotechnology and nanosensors with the main emphasis on their implications and use in diagnosis and treatment of disease states as well as their use in personalized medicine. So far, the course has drawn more than 78,000 participants. This absolutely impressive number is a contribution to efficient dissemination of specialized knowledge in biomedical science and nanotechnology to a wide spectrum of people in both developed and developing countries, without admission bureaucracies.
- 5) **Education:** A few times a week, Haick visits, on a voluntary basis, different places throughout the country (including primary schools, high schools, and non-profit organizations), sharing advances in science and technology and talking about the need for advanced education and excellence. So far, his voluntary efforts have been appreciated, evidenced by a list of awards and decorations, including the "Order of the Merit of Tikun Olam" of the Leo Baeck Education Center, the Al-Khwarizmi Decoration for Educational Contribution for Primary Schools, the YMCA Award, the Lion's Club Award and more.