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# Hakan Ceylan, Dr.

Materials Science and Nanotechnology

## Max Planck Institute for Intelligent Systems, Stuttgart

from September 2020 to February 2021
Born in 1988 in Ankara, Turkey
Studied Molecular Biology, Materials Science, and Nanotechnology at Bilkent University

FELLOWSHIP
College for Life Sciences

PROJECT

# Medical Microscopic Robots for Minimally Invasive Targeted Therapies

I develop microscopic soft machines that can safely navigate in the body, deliver theranostic agents, and perform interventional tasks with high precision, repeatability, and some autonomous capabilities. During my fellowship, I will explore important medical problems on which microrobots can make a disruptive or radical impact.

My career aspiration is to move such disruptive medical technologies into clinics. For this purpose, I will take significant time to communicate with the medical faculty of the Charité, which is Germany's most research-oriented medical institution. One big problem of researchers who develop new cutting-edge biomedical technologies is inadequate communication with their academic fellows in clinics. As a result, a lot of time, money, and human resources are wasted on unused, impractical, or unnecessary products. As a junior researcher who is preparing to launch an independent career at the intersection of basic science, engineering, and translational research, learning the existing clinical problems from the best clinicians and developing realistic potential solutions using microrobotic technologies will give me a more tangible direction. Reciprocally, sharing my unique achievements in this emerging field can spur the clinicians to come up with previously unimagined or impossible new diagnostic or therapeutic ideas. I am enthusiastic that such discussions can also lead to future long-term collaborations around new and unexpected views, ideas, and technologies. These steps will greatly contribute to my cross-disciplinary intellectual interests and the establishment of a globally competitive and ambitious research team in the healthcare technologies.

I will benefit from the multi-disciplinary research environment in Berlin at the highest level possible. Besides the Charité, I will establish a close relationship with the Fritz Haber Institute, the Max Planck Institute for Infection Biology, the Fraunhofer Institute for Reliability and Microintegration, the Fraunhofer Institute for Applied Polymer Research, the Fraunhofer Institute for Cell Therapy and Immunology, Branch Bioanalytics and Bioprocesses, and the Leibniz Institute for Molecular Pharmacology, as I have found that the most significant research and future collaboration overlaps. I will look for opportunities to give research talks at these institutes and at the physical and life science departments of the Freie Universität Berlin and the Humboldt-Universität zu Berlin. I have also found the research topics of the Fraunhofer Institute for Industrial Engineering particularly intriguing, where I can take inspiration for completely new ideas to apply in uncharted territories.

Recommended Reading

Ceylan, H., I. C. Yasa, O. Yasa, A. F. Tabak, J. Giltinan, and M. Sitti (2019). "3D-printed biodegradable microswimmer for theranostic cargo delivery and release." ACS Nano 13, 3: 3353-3362.

Yasa I. C., A. F. Tabak, O. Yasa, H. Ceylan, and M. Sitti (2019). "3D-printed microrobotic transporters with recapitulated stem cell niche for programmable and active cell delivery." Advanced Functional Materials 29, 17: 1808992.

Ceylan, H., I. C. Yasa, and M. Sitti (2017). "3D chemical patterning of micro-materials for encoded functionality." Advanced Materials 29, 9: 1605072.

TUESDAY COLLOQUIUM, 20.10.2020

# Cell-Size Robots for Minimally Invasive Targeted Therapies

Untethered mobile robots the size of a single human cell can make a disruptive impact in medicine. Their small size and wireless mobility can enable access and navigation in small, confined, hard-to-reach, and sensitive inner body sites, such as the central nervous system, the circulatory system, and the fetus. In these locations, such tiny machines can provide new ways of minimally invasive surgical interventions, remain inside for long durations as semi-implantable devices, and deliver targeted diagnosis and therapy with high precision and repeatability. To achieve these goals, however, there are several scientific and technical grand challenges to overcome. In this talk, I will address some of these grand challenges around design, fabrication, and control of cell-sized mobile robots for medical applications. I will demonstrate integrated sensing, response, and motion, the pillars of a robotic system, using out-of-the-box new materials and fabrication strategies on microscopic scales. I will explore alternative power sources and design principles that could realistically sustain robotic operations. I will demonstrate medical microrobots with the capabilities of moving around, sensing, responding to the local pathological information, and performing specific diagnostic and therapeutic tasks in orderly executed physical algorithms using their smart composite material architectures. Upon completing their functions, most of the microrobots I have developed are enzymatically degradable under physiological conditions. Given the progress and the status of this emerging field, I will finally be providing a translational perspective on medical microrobotics research with an application-oriented, integrative design approach in which powering, materials, fabrication, control, localization, and medical functionalities need to be considered altogether at the same time. I will discuss the complexity of the challenges ahead and the potential directions to overcome them.

PUBLICATIONS FROM THE FELLOWS' LIBRARY


Ceylan, Hakan (Weinheim,2019)

3D□printed microrobotic transporters with recapitulated stem cell niche for programmable and active cell delivery

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1725284154

DreiD-printed microrobotic transporters with recapitulated stem cell niche for programmable and active cell delivery

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1725284154

Ceylan, Hakan (Washington, DC,2019)

3D-printed biodegradable microswimmer for theranostic cargo delivery and release

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1724379097

Ceylan, Hakan (Weinheim,2017)

3D Chemical Patterning of Micromaterials for Encoded Functionality

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1725291258

DreiD Chemical Patterning of Micromaterials for Encoded Functionality

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1725291258