Implantable Microfluidic Devices for Cancer

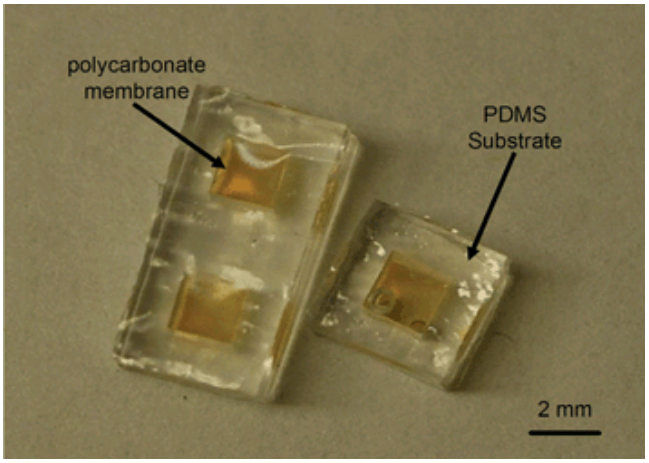
Michael J. Cima, Sumitomo Electric Industries Professor of Engineering, Massachusetts Institute of Technology

Robert Langer, Institute Professor Department of Chemical Engineering, Massachusetts Institute of Technology

Rapid monitoring of chemotherapy delivery and tumor growth would provide clinicians with a valuable tool for personalized medicine. The advent of nanotechnology affords such a tool. Drs. Michael Cima and Robert Langer have designed an implantable microfluidic device which can determine the local concentrations of various substances. This device could be utilized for real time and noninvasive repeat monitoring for cancer. For instance, this device could survey the amounts of chemotherapy which has reached the tumor following systemic administration of drug.

These microfluidic devices are composed of silicone and contain nanoparticles composed of dextran-coated iron oxide. These groups have shown that the silicone casing acts as a protective barrier for the nanoparticles. Moreover, the device can be implanted into a tumor and used for implanted magnetic sensing. For this technique, antibodies to any cancer biomarker are then attached to the surface of the nanoparticles. Clumping occurs when the target molecule is present, and magnetic resonance imaging is utilized to detect the clumping. This will allow researchers to observe the tumor directly over time.

The design facilitates molecules smaller than 10 nm to enter the device; however, the nanoparticles are trapped by a porous membrane. This device boasts several advantages in that it can simultaneously measure several biomarkers and evaluate the amount of chemotherapy. The device can also determine if the tumor is shrinking or if has spread to new locations.



Photograph of sensing devices filled with a solution. The polydimethylsiloxane (PDMS) substrate contains reservoirs which are covered by a semi-permeable polycarbonate (10 nm pore) membrane. The membrane will allow analyte to diffuse into the reservoir and induce nanoparticles aggregation, which is measured by MRI.