searchers achieved 90% cancer cell destruction. Their optical micrographs clearly indicated the rounded cells with membrane shrinkage and loss of membrane integrity under an ac magnetic field of 90 Oe at a frequency of 20 Hz. Through atomic force microscopy measurements and nuclear DNA scission assays results, the researchers hypothesized that membrane rupture alone does not appear to play a dominant role in cancer cell destruction; instead, applied magnetic field to functionalized MD-cell complexes can possibly lead to triggering of intracellular pathways leading to programmed cell death.

The researchers emphasized that these magnetic nanoparticles demonstrate a unique combination of multifunctional properties as they have zero moment in remanence, possess high value of the magnetization of saturation, and can be easily biofunctionalized. The researchers also said, "magnetic microdiscs with a spin-vortex ground state may find further application in distant cell manipulation and separation, controllable force application during regenerative tissue growth, and studies of elasticity in a diagnostic capacity."

Co-authors of the article are S.D. Bader, T. Rajh, M.S. Lesniak, and V. Novosad.

Rohit Khanna

Two-Step Microfluidics Approach Enables Electronic Detection of Biomarkers in Blood

E. Stern, M.A. Reed, and T.M. Fahmy of Yale University, and their colleagues have produced microfluidic device components capable of detecting picomolar levels of cancer biomarkers in whole blood. In the December 13, 2009 online issue of *Nature Nanotechnology* (DOI: 10.1038/NNANO.2009.353), the research team describes a two-step process designed to circumvent the downside of a nanowire sensors' extreme sensitivity. Previously, researchers have shown that nanowire field-effect transistors (FETs) functionalized with antibodies can detect the presence of antigen at clinically relevant picomolar concentrations, but in complex physiological solutions such as blood the ultrasensitive devices are quickly fouled and lose their utility. This has previously limited clinical applications for the technology.

Now, Stern and his colleagues overcome this problem by introducing an upstream microfluidic purification chip (MPC) that captures the antigen of interest, isolates it from other blood components, and releases the antigen into a buffer suitable for use with nanowire sensing. The MPC contains numerous microscopic pillar features, produced by lithographic techniques, that are functionalized with antibodies against prostate-specific antigen (PSA) or carbohydrate antigen 15.3 (CA15.3), commonly used biomarkers for prostate and breast cancer, respectively. The antibodies are attached to the pillars through photo-labile linkers. The antibodies capture their antigens out of whole blood and retain them within the MPC while the other blood components are washed out. After washing, a sensor-compatible buffer is introduced into the MPC and UV light is used to cleave the antigens and attached antibodies from the pillars. The buffer and its load of antigen-antibody complexes can then be transferred to a separate microfab-

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ricated compartment containing the nanosensors.

The researchers used an enzyme-linked immunosorbent assay (ELISA) technique to verify antigen capture to and release from the MPC, and correlated this data with the known concentration of antigen in spiked blood. The research team showed that the MPC-purified complexes produced the appropriate sensor response and demonstrate that this method can be used quantitatively to calculate the level of antigen initially present in the whole blood sample. According to the researchers, this approach brings the potential power of these ultrasensitive electronic nanosensors a step closer to clinical diagnostic use.

KRISTA L. NIECE

Ring-Resonator Design Allows Wide Wavelength Selectivity in Integrated Al_2O_3:Er^{3+} Ring Lasers on Silicon

Er-doped waveguide lasers based on dielectric materials combine properties of dielectric solid-state lasers with the possibility of integration with other photonic components on the same chip, offering high functionality at low cost, especially for applications in telecommunications. In the form of a ring-resonator laser, they offer a simple and straightforward solution for coupling of pump and signal in an integrated manner. J.D.B. Bradley and co-workers from the University of Twente and R. Stoffer from PhoeniX BV, in The Netherlands, have presented in the January 1 issue of *Optics Letters* (DOI: 10.1364/OL.35.000073; p. 73) a Al_2O_3:Er^{3+} laser ring based on a novel ring-resonator design which allows strong coupling of pump light into the ring while simultaneously allowing only a small percentage of output coupling at the signal wavelength. By varying the length of the output coupler, the researchers demonstrated several laser wavelengths in the range 1530–1557 nm, exploiting in this way the broad emission spectrum of this material.

The researchers deposited a 500-nm-thick Al_2O_3:Er^{3+} layer with an Er concentration ~1×10^{20} cm^{-3} on a 8-μm-thick thermally oxidized 10-cm-wide standard Si wafer by reactive co-sputtering from high-purity metallic targets. In the Al_2O_3:Er^{3+} layer, the researchers defined 1.5-μm-wide channel waveguides using standard lithography and reactive ion etching, after which they deposited a 5-μm-thick SiO_2 top-cladding layer by plasma-enhanced chemical vapor deposition, and prepared the end facets by dicing. This resulted in a single-mode channel waveguide at around 1550 nm for both the transverse electric (TE) and transverse magnetic (TM) polarization modes. The waveguide was multimode at the 980-nm pump wavelength, the researchers said. To increase the mode size and improve chip-fiber output coupling of the laser signal, the researchers inverse-tapered the waveguide width to 0.8 μm at the signal output. The researchers designed the ring cavity to obtain a high Q-factor for longer wavelengths, while minimizing coupling at the shorter pump wavelength to launch a significant part of the pump power into the ring. They set the coupler gap to 2 μm and used adiabatic sine bend transitions at the input and output of the coupler with lengths between 350 μm and 600 μm for the coupler, and between 2.0 cm and 5.5 cm for the resonator.

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