the films with an 8 nm layer thickness exhibit a large pyroelectric coefficient between 10°C and 26°C with a maximum value of 4.1×10^{-4} C/m^2 K at 16°C. This result demonstrates that the material is a good candidate for uncooled infrared focal plane array applications.

CORA LIND

Broadband Frequency-Tunable Micromechanical Oscillator Promises to Extend the Applicability of Microelectromechanical Systems (MEMS)

Scientists at the Cornell Center for Materials Research have developed a technique for varying the frequency of oscillations over a 300% range in micron-scale cantilever beams. These cantilevers, which are used as micromechanical oscillators, serve as the basic component in numerous microelectromechanical systems (MEMS) devices. When the oscillators are limited to operation at either a fixed resonant frequency or over a narrow frequency range, as, according to the researchers, has previously been the case, the applicability of these devices is restricted. Systems such as electromechanical filters, micromechanical spectrum analyzers, and magnetic resonance force microscopes (MFRM) may benefit from the researchers' work on broadband tunable microresonators.

As reported in the November 13 issue of *Applied Physics Letters*, M. Zalalutdinov, B. Ilic, D. Czaplewski, and co-workers employed a scanning tunneling microscope (STM) as a vibration actuator and a scanning electron microscope (SEM) as a motion detector in order to excite and detect oscillations in low-stress silicon nitride cantilevers (200 μm × 20 μm × 0.6 μm). By applying a small ac voltage to a z-piezodrive, the tungsten STM tip, while in contact with the cantilever, was driven with <0.1 nm amplitude in the direction perpendicular to the surface, thus causing it to behave as a point-like actuator. The resulting cantilever motion was detected by scanning the SEM electron beam across the cantilever edge and analyzing the secondary electron yield or video signal. By linearly scanning the electron beam over a distance greater than the motion of the cantilever edge, the resonant frequency of the cantilever oscillations was determined from the position of the peak in the resulting spectrum of the video signal.

Using the SEM, the resonant frequency was measured as a function of the STM tip distance from the cantilever end. The researchers report a continuously variable threefold increase in the resonant frequency as the STM was displaced toward the middle of the cantilever. The cantilever's deflection profile at a fixed tip position was also measured using the SEM. In both cases, the researchers found agreement between the experimental data and predictions obtained using the cantilever beam displacement equation.

"This method allows us to vary the cantilever over such a large frequency. Tunable micromechanical oscillators," said Zalalutdinov, "will provide the basis for the realization of solutions for diverse MEMS applications."

STEFFEN K. KALDOR

High-*Q* Microcavity Based on Whispering Gallery Modes Constructed from Microsphere-Core-Shell Quantum Dot Structure

A group of researchers at the University of Oregon in Eugene proposed and developed a quantum dot microcavity with extremely high Q factors. They achieved two important parameters: small effective mode volume and long photon lifetime.

As reported in the November 1 issue of *Optics Letters*, the quantum dot microcavity was achieved by coupling core-shell CdSe-ZnS nanocrystals obtained by organometallic synthesis, with fused-silica microspheres (diameter ~20 μm to a few hundred microns) obtained by fusing a fiber tip with a CO_2 laser. The CdSe-ZnS nanocrystals used have a near-unity quantum yield at room temperature and a narrow linewidth—as determined by photoluminescence measurements (PL) on single quantum dots. To attach the nanocrystals to the fused-silica microsphere surface, the nanocrystals were suspended in a chloroform solution. After taking PL measurements of the composite nanocrystal-microsphere system, free spectral range of the whispering-gallery modes (WGM) of the microcavity was determined to be 0.7 nm for the 100-μm diameter of the sphere. Using a resonant light-scattering technique, the Q factor was found to change its value from 1.6×10^6 to 1.6×10^8, corresponding to WGM linewidths of 4×10^{-4} nm and 5×10^{-6} nm. The difference in the Q values is due to the absorption of nanocrystals coupled with the relevant WGM. Furthermore, in order to increase the accuracy in Q measurement, time-domain ringdown spectroscopy was used in two stages, before and after the sphere surface was reheated. Reheating the sphere surface increased the photon storage lifetime from 0.1 μs to 0.3 μs, corresponding to an increase in Q from 2.4×10^8 to 7×10^8. The researchers concluded that the limiting factor in increasing Q in the composite nanocrystal-microsphere system is the surface absorption on chloroform.

The research team anticipates that an even higher dipole coupling rate can be achieved using spheres with smaller diameters. According to the researchers, the extreme sensitivity of WGMs to the effects of single nanocrystals should open up a new avenue for probing dynamics, decoherence, and individual quantum transitions in a single quantum dot.

IULIA C. MUNTELE

Microprobing Silicon Surfaces Reveals Low-Resistance Surface Reconstructions

An international team of scientists from the Technical University of Denmark and the School of Science of the University of Tokyo in Japan has discovered that using micro-four-point probes to measure the surface conductivity of structure results in a resistance of two orders of magnitude lower than that for Si(111)-$\sqrt{3}\times\sqrt{3}$-Ag clean surfaces. The researchers attribute this difference to direct transport through surface states, an effect that cannot be observed with the conventional macroscopic four-point probes. Clean facets of many crystalline materials exhibit reconstructions of the outer atomic layers, which result in a new two-dimensional band structure at the surface. Although the dispersion of these bands can be measured by spectroscopic techniques, the characterization of charge transport in these surface states still remains a challenge.

As reported in the December 4 issue of *Applied Physics Letters*, the micro-four-point probes were prepared using silicon-based microfabrication technologies, following a procedure similar to that for atomic force microscope probes. The probes consist of four sharpened silicon oxide cantilevers coated with titanium, extending from a silicon chip. Electrode spacings of 8 and 20 μm were produced and used in these experiments. Once produced, the microscopic probes were integrated into a customized ultrahigh vacuum scanning electron microscope system, and manipulated with microslides for making contact with the analysis samples. The samples were 20×3 mm^2 n-type Si(111), with a nominal resistivity of 10–100 Ωcm. The sample surfaces were patterned with laser etching, in order to generate large step-free terraces, and then heated resistively at 1250°C in intervals of 10–60 s for a total of 3000 s. The two surface reconstructions investigated—the Si(111)-7×7 and Si(111)-$\sqrt{3}\times\sqrt{3}$-Ag—