that surface vacancies are responsible for the mobility of the indium, and that this metal surface is far from static, even at room temperature.

A single crystal of Cu (99.999% pure) was polished parallel to the (001) plane. It was cleaned by heating in Ar/H_2 to remove sulfur impurities, sputtering with 600-eV Ar ions in ultrahigh vacuum (UHV) with periodic exposure to a few Langmuir of O_2 to remove carbon, and annealing to 675 K. A 3% monolayer of indium was deposited on the Cu(001) surface from a Knudsen cell. The experiments were performed with a variable temperature scanning tunneling microscope (STM) in UHV. The diffusion of the indium atoms embedded in the copper terrace was followed by making a series of images of the same area on the copper surface to form an STM-movie of the motion (viewable at http://lion.leidenuniv.nl/wwwhome/gastel/measurement.gif).

The researchers discovered that the indium atoms move by long jumps of more than a single lattice spacing, separated by long time intervals, and that nearby indium atoms tend to jump at the same time. The researchers said this strongly suggests that the diffusion of the indium is mediated by vacancies, which diffuse so rapidly that they remain undetectable by STM. The length of the long jump depends on the average number of times that a single vacancy changes places with the indium atom as the vacancy performs a biased random walk. The root-mean-square jump length of the indium atoms is 3.5 nearest-neighbor spacings, and it can be reproduced accurately in calculations if the chemical difference between indium and copper atoms is taken into account. Van Gastel favorably compares the continuous reshuffling of the surface to an atomic version of a slide puzzle.

Erin S. Carter

Nanoscale Patterning of Magnetic Recording Media Allows High-Density Data Storage

With the explosion of the Information Age, the demand for disk space keeps growing; however, magnetic-media manufacturers foresee the limits of the traditional scaling approach to achieving higher area densities where the signal-to-noise ratio is maintained while increasing bit density by reducing the grain size and preserving the number of grains per bit to several hundreds. In this approach, the grains will ultimately become small enough to become thermally unstable and undergo spontaneous reversals of their magnetization direction. One method for alleviating this effect is to create patterns of single-bit domains that have increased thermal stability due to the increased magnetic-switching volume. A group of researchers at the IBM Almaden Research Center in San Jose, California, reported systematic write-and-read experiments on magnetic media patterned at densities as high as 100 Gb/in^2.

As reported in the February 12 issue of *Applied Physics Letters*, the researchers used a focused Ga^+ ion beam to cut 20-nm-wide trenches into 20-nm-thick perpendicular granular $Co_{70}Cr_{12}Pt_{18}$ recording media in order to create islands with lengths from 60 nm (100 $Gb/in.^2$) to 230 nm (10 $Gb/in.^2$). Using a static write-read tester, they have written square-wave bit patterns on these arrays of islands and found that

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read-back amplitudes depend strongly on the write phase, vanishing for writing out-of-phase on the single-domain islands as a result of the fact that bit transitions (domain walls) cannot be placed in the islands, and thus each island would have a 0.5 probability of being magnetized either up or down. The researchers also found evidence that for in-phase writing, there is a reduction of the read-back signal compared with the unpatterned media of identical linear density, which was linked to the reduction of magnetic material associated with patterning, although even the very smallest islands clearly exhibit a periodic signal. The work is still in its beginning stages, and it will continue focusing on improving the stability of the patterned island arrays.

CLAUDIU MUNTELE

Electrical Microdischarge Channel Integrated with Si p–n Diode Allows Efficient Generation of Visible/Near-IR Light

Efforts to generate visible or near-infrared radiation from silicon have a long history, but have been only moderately successful. External quantum efficiencies as high as ~1% are the most that could be obtained after extensive research. A research team from the Department of Electrical and Computer Engineering at the University of Illinois has taken a different approach to overcome the problem, integrating a reverse-biased silicon *p–n* junction with an electrical gas-discharge microchannel as reported in the February 5 issue of *Applied Physics Letters*. The gas discharge driven by a *p–n* junction offers the possibility of fabricating large arrays, and can be directly integrated with electronic and opto-electronic devices.

In designing these devices, C.J. Wagner, S.-J. Park, and J.G. Eden used commercially available diodes with the casings removed. After depositing a poly(methyl methacrylate) (PMMA) film around the perimeter of the exposed area for breakdown prevention, they drilled by ultrasonic milling a cylindrical channel through the ohmic contact and the *p–n* junction. The devices were then filled with the desired pressure of research-grade gas. For a Ne gas pressure of 700 Torr, the wavelength-integrated (300-800-nm) output power was ~48 μW for an operating current of 5.7 mA and a bias voltage of 134 V. Unlike previous hollow and planar cathode microdischarge devices fabricated in Si, no dielectric layer is required with this approach. The simplicity and robust structure of these hybrid semiconductor/gas-discharge devices as well as their suitability for manufacture by conventional photolithographic and laser micromachining techniques make them attractive for arrays and on-chip atomic-frequency standards.

CLAUDIU MUNTELE

Single-Electron Inverter Achieves Voltage Gain of 2.6 at 25 mK

Theoretically, single-electron tunneling devices could be used for computation because they can be made very small and would consume little power. However, few actual logic elements have been built and tested. C.P. Heij, P. Hadley, and J.E. Mooij from Delft University of Technology, The Netherlands, recently fabricated and experimentally tested a single-electron inverter.

As reported in the February 19 issue of *Applied Physics Letters*, the inverter consists of two identical single-electron transistors (SETs) in series, sharing a common input gate, bearing a strong resemblance to a standard complementary metal-oxide semiconductor (CMOS) inverter. Each SET contains a small aluminum island,

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