electronic devices, while the group at UIUC are using their approach to synthesize magnetic nanocomposites for permanent magnet applications.

More Accurate Atomic Clocks May Be Enabled by Optical Frequency Combs from Femtosecond Lasers

Physicist Scott Diddams of the National Institute of Standards and Technology (NIST) and visiting scientist Thomas Udem of the Max Planck Institute for Quantum Optics are part of the NIST team that has developed an optical atomic clock with the potential to be 1000 times more accurate than currently available atomic clocks.

Current atomic clocks operate at microwave frequencies to measure the oscillations of cesium atoms, about 9 billion per second, accurately. The new optical clock operates at a much higher optical frequency, about 100,000 times higher than a microwave clock. Building a clock based on such a high-frequency transition was previously impractical because it requires both "capturing" the ion and holding it very still to get accurate readings, and having a mechanism that can "count" the ticks accurately at such a high frequency. To accomplish this, the scientists use lasers that can deliver pulses of laser light that last just a few femtoseconds. Such lasers typically have their longitudinal optical modes locked to produce a stable optical frequency comb.

As reported in the August 3 issue of *Science*, the clock combines recent advances in three areas of research: the trapping and cooling of atoms and ions with lasers, frequency-stabilized lasers, and an optical frequency "comb" that combines a femtosecond laser with nonlinear optical fibers to provide a simple, direct, and exact linkage between microwave and optical frequencies. It is the last development that enables the device to count individual cycles of such a high frequency without skipping any, and thus permits the readout of time.

The femtosecond laser-based clockwork divides the optical frequency of the clock's "pendulum" into a countable microwave frequency. A single mercury ion serves as the reference for the optical atomic clock, providing long-term stability and accuracy.

Strontium Naturally Tags Salmon from Specific Geologic Areas

Researchers Brian Kennedy, Andrea Klaue, and Joel Blum at the University of Michigan and Carol Folt of Dartmouth College have found that the element strontium, relatively common in bedrock beneath streams, accumulates in the bony tissues of Atlantic salmon and leaves a specific chemical signature, depending on the geology of the watershed in which the fish are living. By taking advantage of the natural variation in strontium isotopes, scientists now can differentiate fish from specific geologic areas without having to use a human-made marker previously attached to a fish.

At a given area in a watershed, strontium isotope ratios are very stable and show little seasonal or temporal variation. Kennedy and his colleagues identified 11 different geologic signatures for 18 regions of the Connecticut River and its tributaries in central and southern Vermont, an area that has been the focus of Atlantic salmon restoration efforts for more than 30 years. Then they looked at the strontium isotope ratios in backbone tissue of juvenile salmon and in otoliths—bits of bony material near the brain known as "ear stones"—of adult salmon. The otoliths become a record of the fish's environment.

Kennedy said, "The chemical information is laid down in the otoliths on a daily basis, and they can be 'read' much like tree rings, but on an even finer scale."

Review Articles

The following review articles relevant to materials research have been published recently.

"Structure Shape and Stability of Nanometric-Sized Particles," by M. José Yacamán, J.A. Ascencio, H.B. Liu, and J. Gardea-Torresdey, *Journal of Vacuum Science and Technology B* **19** (4) (2001) p. 1091.

"Review of the Filtered Vacuum Arc Process and Materials Deposition," by P.J. Martin and A. Bendavid, *Thin Sold Films* **394** (1–2) (2001) p. 1.

"The Energy Balance at Substrate Surfaces during Plasma Processing," H. Kersten, H. Deutsch, H. Steffen, G. M. W. Kroesen, and R. Hippler, *Vacuum* **63** (3) (2001) p. 385.

Announcement of Element 118 Retracted

The team of Lawrence Berkeley National Laboratory scientists that announced two years ago the observation of what appeared to be element 118—the heaviest undiscovered transuranic element at the time—has retracted its original paper after several confirmation experiments failed to reproduce the results.

In a brief statement submitted to *Physical Review Letters*, the same publication in which the original results were announced, the research team stated, "In 1999, we reported the synthesis of element 118 in the (lead-krypton) reaction based upon the observation of three decay chains, each consisting of an implanted heavy atom and six sequential high-energy alpha decays, correlated in time and position. Prompted by the absence of similar decay chains in subsequent experiments, we (along with independent experts) re-analyzed the primary data files from our 1999 experiments. Based on these re-analyses, we conclude that the three reported chains are not in the 1999 data. We retract our published claim for the synthesis of element 118."

In addition to the confirmation tests at Berkeley, scientists at the GSI laboratory in Germany and the RIKEN laboratory in Japan were unable to duplicate the original reported results.

Micro-Organisms Process Gold Oxides into Metallic Gold

In research related to pollution cleanup, a team of University of Massachusetts microbiologists led by researcher Derek