

Stanford Genome Technology Center at Stanford University have introduced a process to detect and potentially identify single DNA molecules labeled with nanoscale gold particles. While other groups have tried to develop such screening technologies using nanopores, Karhanek and colleagues use nanopipettes combined with measurements of electrical activity. They have found that nanopipettes are faster, easier, and less expensive to fabricate than nanopores.

The nanopipettes were produced from standard quartz capillary tubes (inner diameter, 0.7 mm; outer diameter, 1.0 mm) that were pulled to a needle point with nanometer-scale openings at the point end. The pulling was accomplished with the aid of a laser-based pipette puller. The diameter of the opening of the nanopipette is ~50 nm.

The researchers attached gold particles to DNA molecules to facilitate detection. The 10-nm-diameter nanoparticles were prepared, stabilized with dipotassium bis(p-sulfonatophenyl) phenylphosphine, and bound to 24-mer oligonucleotides. Through a series of experiments, the research team focused on detecting ionic current blockade events caused by the DNA-gold particles flowing through the tip of the nanopipette. This was accomplished by placing the nanopipette, filled with a KCl solution and the nanoparticle-DNA colloid, into a bath containing the KCl solution. One Ag/AgCl electrode was placed in the bath as a reference, and another was placed into the wide end of the nanopipette in contact with the solution. The researchers then monitored changes in current flow between the two electrodes and observed current jumps (blockades) whenever the nanoparticle or the oligonucleotide blocked ionic transport through the opening in the nanopipette.

Based on a statistical analysis of the blockade events, the researchers were able to infer structural information of the DNA-gold particles as they flowed through the sensor, including detection of the putative head and tail of the particles. They also observed that the DNA-gold particle often enters the pipette without full translocation. From the experimental data, the researchers said conditions exist for a certain energy profile with energy wells and barriers, causing a trapping and slowing of the molecules during translocation.

Karhanek and his colleagues concluded that this detection technique may lead to new versatile methods not only for the detection and identification of DNA molecules, but also for the detection of protein targets. For this purpose, the nanopipette tip could be functionalized with a target's

conjugate, said Karhanek. Such experiments may shed light on different conformations of the protein-ligand complex. In more general terms, these techniques may be used to study the dynamics and interactions of various biomolecules with their environment. Not only would this be helpful for technological breakthroughs, said the researchers, but it may also help to understand fundamentals about biological processes.

MARKUS J. BUEHLER

### Novel Hexaferrites Show Potential for Microwave Applications

X. Wang and colleagues at Tsinghua University in Beijing have synthesized  $\text{Ba}_3\text{Co}_{2-x}\text{Zn}_x\text{Fe}_{24}\text{O}_{41}$  hexaferrites by the citrate precursor method to obtain a single Z-type phase structure without any secondary phase, with  $x = 0.0, 0.2, 0.4, 0.6, 0.8, 1.0,$  and  $1.2$ . These hexaferrites can find applications in inductors in the microwave region and ultrahigh-frequency communications, as they display high permeability, high thermal stability, and a high cutoff frequency of ~2 GHz.

As reported in the February issue of the *Journal of the American Ceramic Society* (p.478; DOI: 10.1111/j.1551-2916.2005.00081.x), the researchers used x-ray diffraction to characterize the phase structures of the powders, measuring the specific saturation magnetization and coercive field strength of the powders. X-ray diffraction patterns revealed that the formation temperatures of Z-type phase for Zn-substituted  $\text{Ba}_3\text{Co}_2\text{Fe}_{24}\text{O}_{41}$  were between 1150°C and 1200°C. The substitution of Co by Zn ions at tetrahedral sites was found to result in an increase in the specific saturation magnetization. The Curie temperature, determined by thermomagnetic measurements, decreases linearly with the composition, from 410°C for undoped  $\text{Ba}_3\text{Co}_2\text{Fe}_{24}\text{O}_{41}$  to 382°C for the composition with  $x = 1.2$ .

The researchers said that  $\text{Ba}_3\text{Co}_{2-x}\text{Zn}_x\text{Fe}_{24}\text{O}_{41}$  has high thermal stability and exhibits excellent magnetic properties; permeability rises to 9.8 for  $x = 1.2$  from 4.3 for the undoped ( $x = 0$ ) samples, while the resistivity remains above  $10^9 \Omega \text{ cm}$  for samples sintered at 890°C for six hours. The researchers said that the low-temperature-sintered  $\text{Ba}_3\text{Co}_{2-x}\text{Zn}_x\text{Fe}_{24}\text{O}_{41}$  will be a good candidate as a ferromagnetic material for use in multilayer chip inductor and multilayer chip beads at high frequencies.

VIVEK RANJAN

### Nitroxide-Mediated Polymerization of Styrene Demonstrated in a Continuous Tubular Reactor

Nitroxide-mediated polymerization (NMP), atom transfer radical polymeriza-

tion, and reversible addition-fragmentation transfer polymerization are frequently used in controlled free-radical polymerization. Compared with conventional free-radical polymerization, controlled free-radical polymerization provides narrow molecular-weight polydispersity, block copolymers, and complex structures. In the February 21 issue of *Macromolecular Rapid Communications* (p. 221; DOI: 10.1002/marc.200400531), T.E. Enright and B. Keoshkerian of the Xerox Research Centre of Canada and M.F. Cunningham of Queen's University, Canada, reported polystyrene preparation by a nitroxide-mediated mini-emulsion polymerization in a continuous tubular reactor. They used this method not only to simplify the polymer's synthesis with controlled microstructure, but also to provide better temperature and pressure control during the reaction. In addition, said Cunningham, "industry has expressed concerns over having to pressurize a batch (tank) reactor to run NMP in mini-emulsion, as it is not a standard practice, and the existing equipment is not well-suited for pressurized operation. However, tubular reactors can easily accommodate the modest pressures required (~300 kPa) and would be less expensive than tank reactors."

In the NMP of styrene, bulk prepolymerization was performed in batch by mixing styrene with benzyl peroxide and 2,2,6,6-tetramethyl-1-piperidinyloxy (TEMPO) in a 2 l stainless-steel reactor. TEMPO was used as the nitroxide-mediating agent. After the reactor was heated up to 135°C and cooled to room temperature, the monomer-polymer (a low-conversion polystyrene oligomer) mixture was dispersed in the aqueous phase, which was a sodium dodecylbenzenesulfonate deionized water solution. Then the mixture went through a homogenizer under a pressure of 400–600 bar, and the mini-emulsion latex was formed. Upon filling with the latex at the desired feed rate, this continuous reaction was performed in a 167 m stainless-steel tube coil in a 135°C oil bath. A simultaneous batch reaction was also done for comparison.

In either continuous or batch reaction, a stable latex was formed with a volume mean particle size of  $164 \pm 61$  nm in the batch reactor and  $170 \pm 59$  nm in the continuous reactor. Upon calculation, the coagulum left in both reactors was less than 0.5 wt% of the overall polymer. Both reactions showed very similar kinetic behavior such as the reaction conversion and rate. The polymers were characterized by gel permeation chromatography. For the polymer obtained from the tubu-