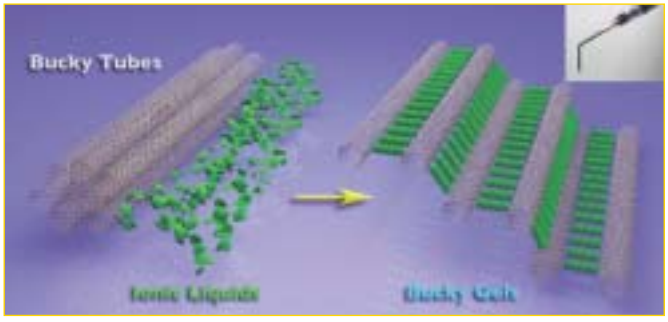
Organizing matter from the bottom up

CONFERENCE REPORT



'Bucky gels' SWNTs dispersed in an ionic liquids (inset shows extrusion through syringe).

The E-MRS Spring Meeting that took place earlier this year in Strasbourg included a symposium designed to bring together chemists and physicists dedicated to the use of self-assembly for the generation of new materials. Thanks to the excellent organization of Paolo Samorì (ISOF-CNR Bologna), Franco Cacialli (University College London), Alan Rowan (University of Nijmegen), and Harry Anderson (University of Oxford), the symposium featured a highly interdisciplinary program with topics ranging from organic synthesis over photophysics to imaging and nanomanipulation.

The symposium opened with a key-note lecture given by Jean-Marie Lehn (ISIS-Université Louis Pasteur Strasbourg), who convinced the audience that self-organization of matter will have a significant impact on the future generation of nanosized structures.

The two following invited speakers both focused on the preparation of new materials based on graphite-like building blocks. While Takuzo Aida of the University of Tokyo presented his work on the practical modification of single walled carbon nanotubes (SWNTs) to enhance their processability for better integration into organic materials, Klaus Müllen of the Max Planck Institute, Mainz demonstrated the use of *de novo* synthesized, extended aromatic molecules for the design of a variety of structures with advantageous materials properties. Aida's approach makes use of attractive π,π-stacking interactions between the tubes' aromatic periphery and cationic imidazolium head groups to achieve fine dispersion of the SWNTs in corresponding ionic liquids (as shown). In the presence of 0.5 wt.% SWNT, a simple grinding procedure affords so-called 'bucky gels' that can be extruded through a syringe (as shown). Subsequent polymerization of the bucky gels can be achieved by incorporating polymerizable acrylate groups into the ionic liquid. The resulting 'bucky plastics' display enhanced mechanical and conducting properties. The incorporation of 3.8 wt.% SWNTs leads to a 400% increase in dynamic hardness and a significant conductivity of 0.56 S/cm.

Müllen has pioneered the field of giant aromatic compounds and presented an overview of his research group's latest achievements. Initial repetitive synthesis of polyphenylene dendrimers affords shape-persistent, three-dimensional objects with tunable nanoscale dimensions and tailored functionality. Introduction of various chromophores and biolabels affords defined functional nanoparticles for artificial light-harvesting systems and diagnostic applications. With the aid of a unique, intramolecular annelation reaction, the spherical dendrimers can be transformed into disk-like objects that resemble large graphite fragments. Given a suitable substitution pattern, these large disks can be stacked into long columns that display considerable conductivity along the column axis. In addition to inducing columnar order in the bulk, the researchers were also able to organize the disk-like molecules in an edge-on fashion on solid substrate surfaces and within sacrificial porous alumina templates to yield supramolecular wires and new types of carbon nanotubes, respectively.

Stefan Hecht

Room at the top as well as the bottom?

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The 7th International Conference on Nanostructured Materials, nano2004, opened with overviews of where nanotechnology is now and where it could be in the future. Hermann Gerlinger of Carl Zeiss reviewed the enormous achievements that the microelectronics industry has made at the nanoscale. Nanotechnology now forms the foundation of this state-of-the-art, trillion-dollar industry, he says. While progress has been astounding, there are challenges ahead to keep the semiconductor roadmap on track. Lithography is one of many. To overcome the current feature size limit of ~70 nm using ArF light sources, immersion technology and extreme ultraviolet techniques will be required in the next few years.

Nobel Laureate Jean-Marie Lehn of Université Louis Pasteur focused instead on the future and how chemistry can go beyond the molecule. We should not only be looking for small things, he said, but more complexity. To paraphrase Richard Feynman, "there's even more room at the top," said Lehn. This complexity will come from supramolecular chemistry, which will provide the means for molecular recognition and directed self-assembly. Despite the many benefits of nanotechnology, the potential societal, health, and environmental risks and hazards add a new level of complexity. The conference covered both conflicting interests. Impressive presentations from Jörg Kreuter of J. W. Goethe-Universität Frankfurt and Andreas Jordan of MagForce Applications GmbH and Charité-University Medicine Berlin revealed how polymeric and magnetic nanoparticles, respectively, have promise for the delivery of chemotherapy drugs and treatment of brain cancers. In contrast, Kevin Ausman from the Center for Biological and Environmental Nanotechnology at Rice University discussed some of the latest nanotoxicology results.

Cordelia Sealy