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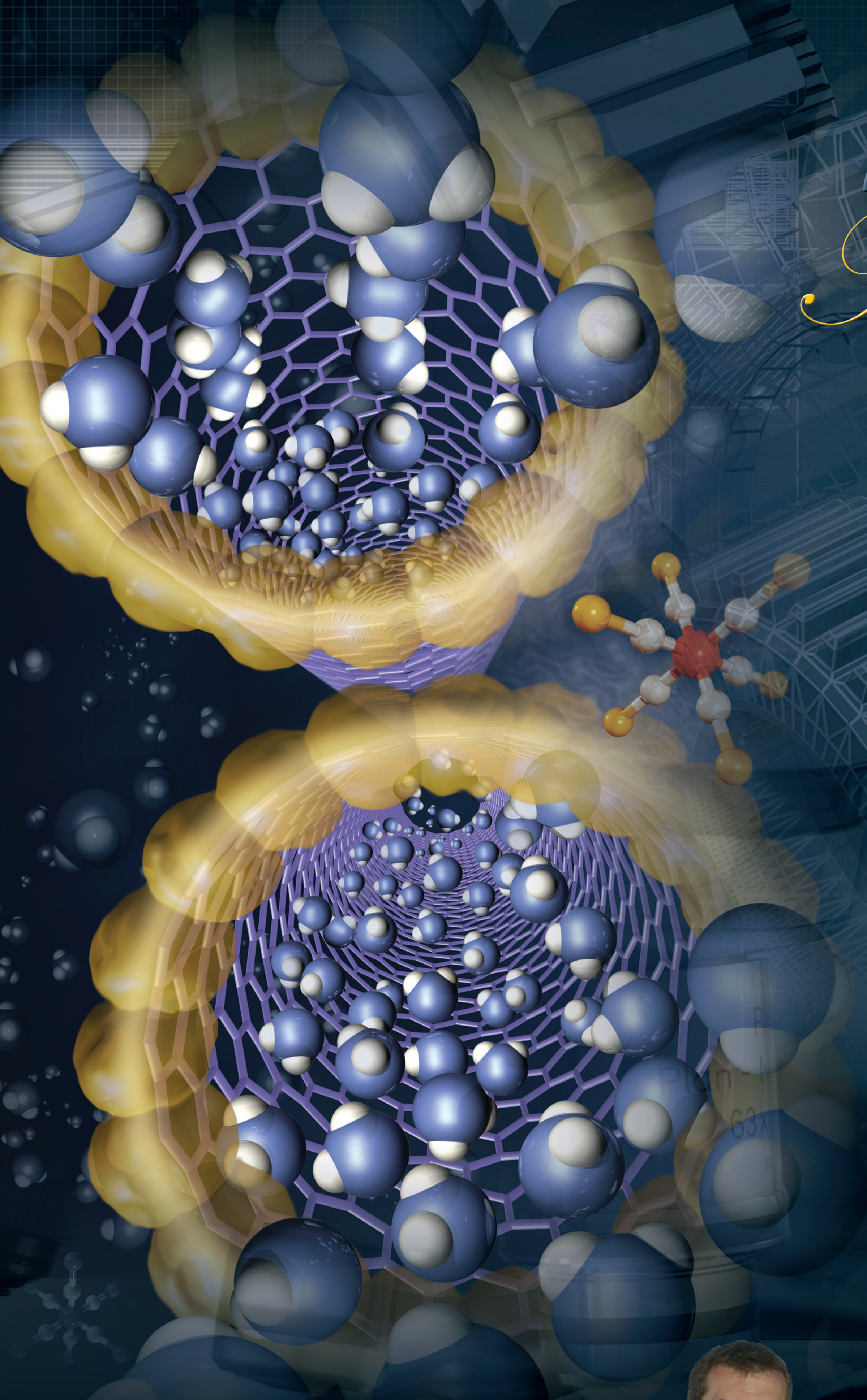
2010 R&D 100 Award Winner



TAKING THE SALT OUT OF THE SEA

A novel membrane technology based on carbon nanotubes (CNTs) could lead to more cost-effective filtration processes for water desalination and reclamation than are available today. These highly permeable, chemically inert membranes have pores made of CNTs—hollow, seamless cylinders with extremely smooth interior walls that allow liquids and gases to rapidly flow through, while rejecting larger molecules.

Molecules Go with the Flow

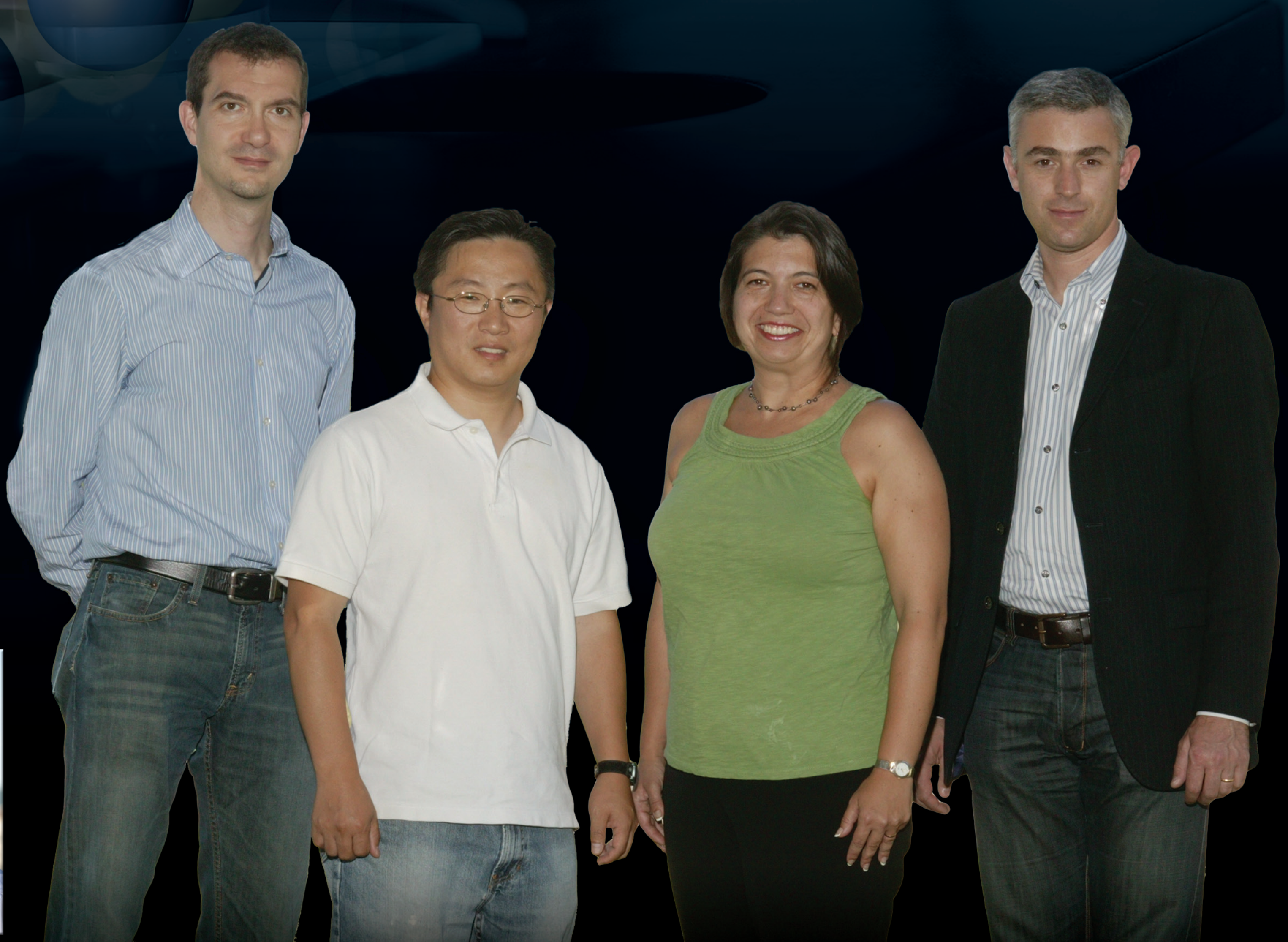
Billions of CNTs, each one about 50,000 times thinner than a human hair, are grown on a single silicon substrate using chemical vapor deposition. The space between this "forest" of nanotubes is then filled with a matrix material such as silicon nitride to create the membrane. Excess material is removed from both ends, and the top and bottom of the nanotubes are reopened using a reactive ion-etching process. Water flows through them at a rate 1,000 times faster than through pores of conventional polymer-based membranes.

Versatile Membranes

CNT assemblies can be built to the specifications required for replacing membrane cartridges within existing equipment, eliminating the potential for additional infrastructure costs to support the technology. They could potentially overcome the limitations of gas separation membrane technologies as well as current carbon dioxide separation processes. From helping to increase the world's clean water supply to reducing carbon emissions, CNT membranes may become essential to managing natural resources for future generations.

Inside an atomically smooth carbon nanotube, water molecules form linear chains flowing at an ultrafast rate. Shown is an ion being rejected by a carbon nanotube pore. Filtration membranes composed of carbon nanotubes could make water desalination processes more efficient and cost effective.

Formerly of Livermore: (from left) Jason Holt and Hyung Gyu Park.



Livermore carbon nanotube development team: (from left) Francesco Fornasiero, Sangil Kim, Olgica Bakajin, and Aleksandr Noy.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-POST-459916