M. Jobbágy and co-researchers at Consejo Superior de Investigaciones Científicas-CSIC, Madrid, Spain, Universidad de Buenos Aires, Argentina, and Centro Interdisciplinario de Nanociencia y Nanotecnologia, used urease-functionalized silica as an interface for nucleation and growth of HAp-like coatings under mild conditions and short aging times.

As reported in the December 23, 2008 issue of *Chemistry of Materials* (DOI: 10.1021/cm8021566; p. 7368), Jobbágy and co-researchers functionalized monodisperse, submicrometer silica spheres as model substrates by covalently attaching urease. The bioactive silica was then aged for 6 hours in a mineralizing solution containing Ca(II), P(V), and urea, at pH 4.0 in order to maximize Ca(II) and P(V) solubility and prevent irreversible urease denaturation. A control experiment was performed with a nonsilica substrate. Transmission electron microscopy (TEM) showed that mineralization transformed the smooth surfaces of the urease-capped silica spheres to rough surfaces with flake-like texture, while the control spheres remained smooth. The researchers observed no uncoated or partially coated silica spheres, nor did they observe free HAp-like flakes greater than 10 nm in length. The mineral coating was characterized with TEM and scanning electron microscopy (SEM) in conjunction with energy dispersive spectroscopy (EDS). TEM-EDS showed that the coating's Ca/P ratio for isolated spheres is about 1.6, which is close to that for HAp, while SEM-EDS showed the same composition for large clusters of coated spheres. X-ray diffraction confirmed the coating's crystalline nature. The researchers said that the mechanism of coating formation is likely direct growth of HAp-like particles onto the silica surface rather than homogeneous nucleation followed by heterocoagulation of HAp-like particles onto silica. The researchers also said, "This method can be applied over different geometries, allowing the design of novel biocompatible films, scaffolds, core–shell nanoparticles, and so forth. Since other relevant carbonate- and/or fluoride-based biominerals can also be developed by urease, in the presence of labile macromolecules or gels, this route allows the preparation of a wide range of biocomposites."

STEVEN TROHALAKI

Accordion-Like Honeycombs Achieve Compatibility for Cardiac Tissue Engineering

The fundamental goal of tissue engineering is to make tissue-engineered constructs with a potential to replace the biological functions of damaged organs. There is now worldwide activity in the *in vitro* regeneration of tissues including skin, nerve, liver, cartilage, bone, heart valves, blood vessels, and kidney. For myocardial tissue engineering, the key is to engineer three-dimensional (3D) cardiac tissue that could eventually be used to repair damaged heart tissue inside the body, test new cardiac drugs, and study cardiac cell development and functions. In principle, it could theoretically lead to the creation of an entire heart. Among the major challenges in developing tissue-engineered grafts for myocardial repair are to achieve structural and mechanical compatibility of 3D scaffolds with the formation of new biomimetic tissue. G.C. Engelmayr Jr. of the Massachusetts Institute of Technology (MIT), L.E. Freed and C.J. Bettinger of MIT and the Charles Stark Draper Laboratory, and their colleagues have recently attempted to overcome this challenge by

https://doi.org/10.1557/mrs2009.42 Published online by Cambridge University Press

microfabricating biomimetic scaffolds from a synthetic bioresorbable elastomer.

As described in the December 2008 issue of *Nature Materials* (DOI: 10.1038/nmat2316; p. 1003), the researchers designed a novel biomimetic scaffold with an accordion-like honeycomb structure, and reasoned that these scaffold materials can mimic anisotropic mechanical response of native myocardium, provide low resistance to contraction, and can also provide structural capacity to guide cardiomyocytes under the physiological environment. The researchers designed the biomimetic scaffolds by overlapping two 200 μm × 200 μm pores oriented at 45° (i.e., diamond-shaped) which left a planar network of undulated, 50-μm wide struts. Accordion-like honeycomb scaffolds were fabricated from ~250-μm thick poly(glycerol sebacate) (PGS) membranes on silicon wafers by an excimer laser microablation technique. Using this technique, the researchers were able to design well-defined features with varied effective stiffnesses (~57 kPa, 195 kPa) of PGS scaffolds as also controlled by varying the curing conditions (i.e., 16 h/160°C and 7.5 h/160°C, respectively).

The researchers also made bilaminar scaffolds to produce a 3D pore network (thickness ~400 μm) by the microablation technique. The scaffold was stabilized by crosslinking through autoclaving at 121°C for 30 min. The novel design of accordion-like honeycomb scaffolds with controlled 3D pore networks gave the desired anisotropy in effective stiffness values in preferred and cross-preferred directions. Most importantly, the researchers were able to find a good match between the mechanical properties of 3D polymer scaffolds with that of adult right ventricular myocardium in the linear physiologic strain regime. Pores were patterned using G code computer program. Scaffolds were loosened from wafers in deionized water for 24 h and then sterilized using 70% ethanol for 24 h.

The researchers focused their studies on the adult rat right ventricular myocardium as the right ventricular myocardium was more anisotropic and compliant than its left ventricular counterpart. They envisioned that right ventricular myocardial grafts have a potential to grow, regenerate, and remodel, which could be useful in repairing congenital heart defects. PGS scaffolds with varying effective stiffnesses and bilaminar scaffolds were autoclave-sterilized, seeded with freshly collected neonatal rat heart cells obtained from 2-day old neonatal rat hearts, and cultured *in vitro* for 1 week. The researchers also applied electrical impulses to the scaffolds materials to assess the effect of scaffold microstructure on construct electrophysiologic properties. For these studies, honeycomb scaffolds (5 mm × 5 mm; 16 h/160°C) with varying pore structure were autoclaved-sterilized and then seeded first with cardiac fibroblasts at ~1×10^6 cells/cm^2, and after 5 days, a heart cell population enriched for cardiomyocytes at 36×10^6 cells/cm^2 were added and cultured *in vitro* for 1 week. Researchers demonstrated that all scaffold materials exhibited contractions. Orientation of cultured heart cells was evaluated using confocal laser microscopy with F-actin staining and fast-Fourier Tranform (FFT)-based image analysis. Their preliminary studies on 3D porous bilaminar scaffolds suggest that these scaffolds have the capability to generate multilayered tissue structures with neonatal heart cells.

The researchers concluded that accor-

https://doi.org/10.1557/mrs2009.42 Published online by Cambridge University Press

dion-like honeycomb scaffolds have the potential to overcome the major challenges with structural and mechanical integrity of scaffolds for myocardial tissue engineering by closely mimicking the anisotropic mechanical properties of adult rat right ventricular myocardium, while simultaneously promoting the preferential orientation of cultured neonatal heart cells in absence of external stimuli.

ROHIT KHANNA

Air-Stable ZnO Cathode Enables White Light-Emitting HyLEDs

Organic light-emitting diode (OLED) technology has become increasingly popular due to its potential for energy efficient alternate lighting sources. OLED displays function without the assistance of a backlight, which allows them to use much less power and provides longer performance lifetimes in comparison to their liquid-crystal display (LCD) alternatives. OLEDs depend on a multilayered structural design, and can ultimately be used to produce very thin displays which are highly desirable consumer features. However, the vacuum deposition methods used to fabricate the multilayer structures can be cost prohibitive, and the final product can degrade upon exposure to oxygen and humidity. Solution processable OLEDs using inorganic materials like ZnO as injection layers address these challenges in that they have the potential for improved lifetimes and can incorporate materials that make them more cost efficient to produce. In the February 10 issue of *Chemistry of Materials* (DOI: 10.1021/ cm8031362; p. 439), H.J. Bolink, E. Coronado, and M. Sessolo from the Universidad de Valencia, Spain report on a white hybrid organic–inorganic light-emitting diode (HyLED) using air-stable ZnO as the cathode in the fabrication of an electroluminescence device. By efficiently overcoming the electron injection barrier, white light-emitting HyLEDs offer the promise for less rigorous encapsulation which makes them especially suited for low-cost lighting applications.

As reported by the researchers, 80-nm thick ZnO layers were deposited on an indium-tin-oxide–coated glass substrate by spray pyrolysis. A blue polymer matrix emitting host, poly(9,9-dioctylfluorenyl-2,7-diyl), was doped with an iridium-(III)bis (2-methyldibenzo-[f,h] quinoxaline) (acetylacetonate) ($Ir(MDQ)_2(acac)$) complex as orange dye, and dissolved in chlorobenzene. The iridium complex is an efficient emitter in hole-dominated charge transporting environments and has previously been employed in multilayer white OLEDs. Decreasing the concentration of the Ir complex reduces the orange phosphorescence as the blue fluorescent component increases. Most significantly, decreasing the complex concentration from 0.5% weight-in-weight (w/w) to 0.02% w/w induces an emission broadening and hence a color change from orange to white.

The basic design rules used for OLEDs are applied toward HyLEDs in this study to illustrate how transition metal oxides can function as charge transport and, particularly, electron injection layers in HyLEDs. This demonstrates the possibility to prepare air-stable white electroluminescent devices and consequently enhances the feasibility of HyLEDs as real competitors to OLED electronic device technology.

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https://doi.org/10.1557/mrs2009.42 Published online by Cambridge University Press