A collaborative research endeavor between two PTC faculty has led to the production of porous materials of varied mechanical properties, based on block copolymers of polycarbonates prepared from CO₂ gas. The groups of Dr. Emily Pentzer, associate professor of materials science and engineering, and Dr. Don Darensbourg, distinguished professor of chemistry and recently elected member of the National Academy of Science, worked collaboratively on this project. The work was published in Angewandte Chemie and the lead author on the study is Dr. Peiran Wei from the Texas A&M Soft Matter Facility; co-authors include Dr. Gulzar A. Bhat (TAMU chemistry), Ciera Cipriani (TAMU materials science and engineering), Dr. Hamza Mohammad (TAMU chemistry), and Krista Schoonover (TAMU chemistry).

A series of triblock copolymers consisting of soft and hard blocks were prepared by the alternating co-polymerization of CO₂ and epoxides, leveraging chemistry developed in the Darensbourg lab. The hard blocks of the polymer contained pendant alkene groups of that could be used for chemical modification. Thixotropic inks suitable for direct-ink-write (DIW) additive manufacturing were formulated by dissolving the block copolymers in the organic solvent N,N-dimethylformamide (DMF) and then adding in NaCl particles of controlled size and concentration. The inks were loaded into a syringe and then printed and submerged in water to both remove the solvent and the NaCl from the printed objects.
Continues from page 1 — "3D Printed CO2-Based Triblock Copolymers and Post-Printing Modification" 

The printed porous polycarbonate structures had mechanical properties dependent on the ratio of the hard and soft blocks. Characterization of the surface and cross-section by SEM revealed an open-cell porous foam-like structure throughout. Compression tests performed with a dynamic mechanical analyzer (DMA) revealed that the stiffness and strength of the materials increased with an increased proportion of hard block of the copolymer. Further, a 15-pound (~6.8 kg) weight could be supported by a porous printed lattice composed of ~0.2 g of the polycarbonate containing a 1:1 molar ratio of the soft and hard blocks, highlighting the high strength of the printed copolymers.

The chemical composition of the polymer feedstock, specifically the alkene groups of the hard block, could be used as handles for chemical modification or cross-linking. The printed and washed porous structures were modified using UV-initiated thiol-ene click reactions with primary thiols, giving coverage with, e.g., alkylbromides, as confirmed by FTIR spectroscopy, XPS, and SEM-EDS. Further, incorporation of the a tetra thiol in the ink, along with UV curing of the printed object enabled the hard blocks of the porous structure to be chemically cross-linked. By temporally controlling this cross-linking, the stability of the printed object could be tailored: the non-cross-linked regions could be dissolved in organic solvent, but the cross-linked polymer regions could not. However, the cross-linked polycarbonate regions could be chemically degraded in < 24 h upon submersion in an aqueous solution of sodium hydroxide.

The ability to tune the composition of the copolymer and the structure of the printed objects will enable tough and lightweight polycarbonates to be used for a variety of applications, such as organ culture or bone regeneration. Moreover, the surface of the printed object could be modified with, e.g., cell growth factors to induce bone formation. In complement, chemical cross-linking of the polymers can be used to increase mechanical strength, making them more suitable for weight-bearing applications or structural components.

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Dr. Perla Balbuena has been selected as a 2022 fellow of The Electrochemical Society (ECS).

"I'm extremely happy to be named an Electrochemical Society Fellow," said Balbuena. "The ECS Fellow is one of the highest honors for a professional in the fields of electrochemistry and solid-state science and technology. The selection process is extremely thorough and requires true peer recognition."

Balbuena is one of 15 ESC members selected for the 2022 class. She has served as an ECS member for many years. During her time in ECS, she has organized and chaired meeting symposia at national and international conferences. In April 2021, she was appointed the associate editor of the Journal of The Electrochemical Society.

Full story: https://bit.ly/3BmLn1m
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Students that have received the Polymer Specialty Certificate  75

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