abstract

Origami, creating three-dimensional (3D) structures from two-dimensional (2D) sheets through a process of folding along creases, has been transformed by mathematicians, scientists, and engineers to utilize the folded objects’ deformability and compactness in applications ranging from space exploration (e.g., a foldable telescope lens), to automotive safety (e.g., airbags), biomedical devices (e.g., heart stent), and extremely foldable and stretchable electronics. Notable progress has been made in the area of origami theory, particularly on methods and tools to design origami models and to understand folding and unfolding from a theoretical perspective. Among classes of origami patterns, a particular one, namely rigid origami, in which the faces between the creases remain rigid during folding/unfolding and only the creases deform, is different from most origami patterns that require face bending or partial crumpling to make many-step folds.

This presentation consists of two parts. The first part demonstrates the fabrication of origami electronics that has superb flexible, stretchability and foldability. The fabrication processes here represent an example to utilize mainstream high-temperature processes to fabricate high-performance stretchable electronics. Two examples, namely origami solar cells and origami lithium ion batteries will be presented. The second part describes mechanical metamaterials created by origami in terms of their basic geometric and stiffness properties, as well as load bearing capability. A periodic Miura-ori pattern and a non-periodic Ron Resch pattern will be presented. (cont’d.)

(abstract cont’d.) Unexceptional coexistence of positive and negative Poisson’s ratio are found for Miura-ori pattern, which are consistent with the interesting shear behavior and infinity bulk modulus of the same pattern. Unusually strong load bearing capability of the Ron Resch pattern will be discussed due to the unique way of folding.

It is expected that this work paved the way to explore new and exciting engineering applications of origami

biosketch

Dr. Hanqing Jiang is an Associate Professor in the Mechanical and Aerospace Engineering in Arizona State University. Dr. Jiang received Ph.D. from Tsinghua University in 2001, majoring in Solid Mechanics. His current research interest is the integrated hard and soft material, specifically including origami electronics, lithium-ion batteries, and hydrogels. He has published 5 book chapters and 95 peer-reviewed journal papers, including multi-disciplinary journals (Science, PNAS, Nature Communications), materials journals (Advanced Materials, Advanced Energy Materials), nano journals (Nature Nanotechnology, Nano Letters), physics journals (PRL, PRB, APL, JAP), and mechanics journals (JMPS, IJP, IJSS, JAM). Many of his papers are among the top cited papers in mechanics and/or mechanical engineering communities.