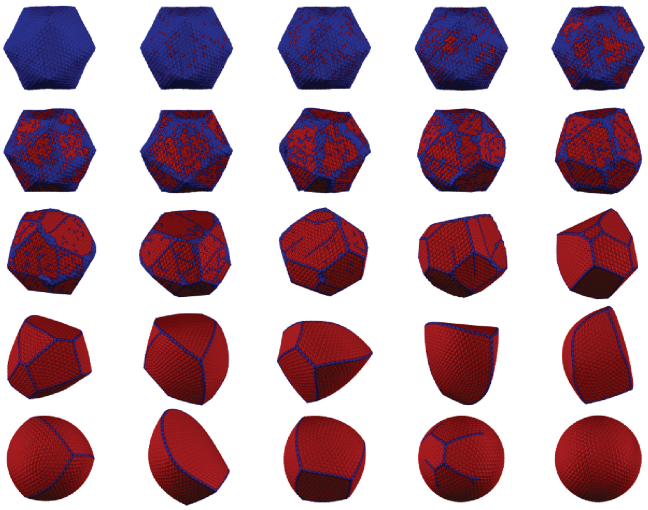
Argonne NATIONAL LABORATORY

Monica Olvera de la Cruz

Polyhedral Crystalline Membranes

Polyhedral geometries have beguiled scientists and mathematicians for millennia. In recent times, polyhedral shapes have been identified at the microscopic level in crystalline shells such as fullerenes, viral capsids, and protein-based bacterial organelles. The most frequently found polyhedron in homogeneous crystalline shells is the icosahedron. This talk demonstrates that other geometries arise spontaneously in shells formed by more than one component. The spontaneous buckling of a crystalline shell with two co-existing elastic components at different relative concentrations is described. Computational and experimental evidence will be provided for the spontaneous buckling phenomena in shells made of mixtures of cationic and anionic amphiphiles, where electrostatics drives their co-assembly, and orders the assembly into faceted ionic structures with various crystalline domains. This work explains the existence of various regular and irregular polyhedral shells found in nature, and provides the principles for designing nanocontainers with specific shapes and symmetries for numerous applications in the materials and life sciences.



Monica Olvera de la Cruz obtained her B.A. in Physics from the Universidad Nacional Autonoma de Mexico in 1981, and her Ph.D. in Physics from Cambridge University in 1985. She is the Lawyer Taylor Professor of Materials Science & Engineering; Professor of Chemistry, Physics, and Astronomy; and of Chemical & Biological Engineering at Northwestern University. She has developed theoretical models to determine the thermodynamics, statistics, and dynamics of macromolecules in complex environments including multicomponent solutions of heterogeneous synthetic and biological molecules, and molecular electrolytes. She is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and a Fellow of the American Physical Society. She is a recipient of the DOD National Security Science and Engineering Faculty Fellowship, the Cozzarelli Prize of the Proceedings of the National Academy of Science, the NSF Presidential Young Investigator Award, the Alfred P. Sloan Fellowship, and the David and Lucile Packard Fellowship in Science and Engineering. She is a member of the DOE Basic Energy Sciences Advisory Committee and of the NRC Board of Physics and Astronomy. She is an author of over 200 publications.

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