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# Layered biomimetic and kirigami nanocomposites

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**LAYERED BIOMIMETIC AND KIRIGAMI NANOCOMPOSITES**

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Finding materials with combinations of several extreme properties is one of the key requirements for the successful engineering of adaptive systems. Successful realization of such materials requires new choices for nanoscale components and new manufacturing approaches. Layer-by-layer assembly (LBL) is one of such technique that affords engineering of nanocomposite materials based on sequential adsorption of nanometer scale layers of polymers and inorganic particle, nanowires, nanotubes, sheets, etc. Importantly, it can lead to the materials with seemingly “impossible” combinations of physical properties encompassing mechanical, electrical, optical, and biological characteristics and distinct pathways to scalability. Hard-to-reach combinations of electrical and mechanical properties necessary for a number of technologies will be discussed. Composites with high stiffness properties + high damping and as well as high stiffness + transparency will be demonstrated. Energy and biomedical applications are particularly demanding on materials used. A new type of nanoscale “building blocks’ such as aramid nanofibers (ANFs) can also be incorporated in such composites with potential applications as ion conductors for lithium ion batteries. It was demonstrated that LBL assembled nanocomposites enable lithium battery anodes with ultrahigh discharge rates. Incorporation of aramid nanofibers also affords combining high toughness and ion conductivity essential for battery separators. ANF-based Li ion conducting separators are capable of suppressing lithium and copper dendrites with nanometer scale overall thickness.

The last part of the talk will describe our latest exploits in the area of composites to achieve the combination of high conductivity and high stretchability. The studies that will be highlighted include composites enabling self-organization processes during deformation and kirigami materials that display unusually constant conductance over a wide range of strains.