Transparent Composite Materials for Flexible Electronics

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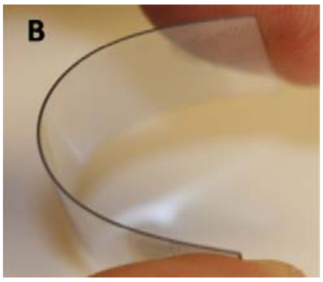
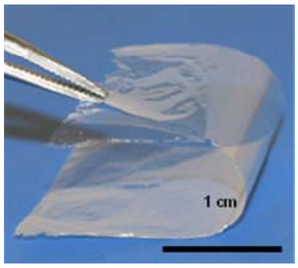
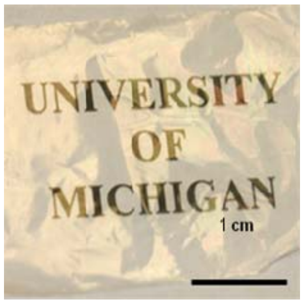


New frontiers in electronics pose significantly new challenges for materials scientists. The advent of flexible electronics and the need to satisfy not only the benchmarks of electrical and optical properties but also the those of wearability/durability, greatly elevate the importance of different mechanical characteristics in the materials for standard electronic devices, which were much less relevant for silicon-based technologies with rigid substrates. Nanoscale composites provide virtually ideal design space for the new generation of electronic materials. This presentation will focus on the transparent conductive, non-conductive, and protective materials with high performance mechanical properties. A new composite structure made of very inexpensive components using a technique called layer-by-layer assembly (LBL) achieves exceptional tensile strength, Young's modulus, and heat resistance, combined with excellent transparency and flexibility. Such combination of properties was attained by careful design of nanoscale structure of the material inspired by natural biocomposites in seashells. The presentation will also analyze the state-of-the-art in the area of transparent conductive materials for ITO replacement. Carbon nanotubes materials were suggested as an alternative to brittle semiconducting oxides, but they also lack many necessary mechanical characteristics. Using the same LBL technique, we demonstrated that it is possible to combine electrical, optical and mechanical characteristics in one material which will satisfy tough requirements of flexible electronics. A new figure of merit to evaluate materials potential for transparent conductors will be introduced and many standard materials will be evaluated from this perspective. Finally, the capabilities of nanocomposites to serve as a protective or encapsulating coating over new electronic devices will be demonstrated. Clay-polymer films can serve both as a protection from environmental de-doping of organic/SWNT conductor films as well as a protection against water and oxygen. Methods of preparation of free-standing membranes suitable for encapsulation of many electronic devices and protective coatings from electronics-friendly solvents will be demonstrated.





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