ADDING SOME "DIRT" TO "CLEAN" ENERGY: APPLYING CLAY NANOCOMPOSITES IN SOLAR CELLS

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Polymer clay nanocomposite (PCN) thin films have found application across a number of applications, ranging from oxygen barriers to flame retardants, where their resistance to molecular gas diffusion has proven remarkably effective, even in films only a few hundred nanometers thick. Deposited using a layer-by-layer processing approach that takes advantage of self-assembly of the constituent components, these composite thin films comprise highly organized, alternating molecular layers of functional polymers and exfoliated clay platelets, commonly montmorillonite or vermiculite. Here, we explore the potential application and utility of PCN thin films in solar cells, where they serve as conformal, transparent barrier films with the potential to impact solar cell lifetime, reliability, and safety. Solar cell failures commonly result when environmental moisture and corrosive or reactive gases penetrate a cell's encapsulant. Moreover, such cell degradation can manifest as a gradual decline in solar cell performance or, in the case when degradation leads to significantly damaged electrical elements, much more dramatic arc-faults that can lead to complete and dramatic module failure, even igniting module fires. Here, we describe how the unique nanostructure, materials chemistry, and gas barrier properties of PCNs offer promise toward addressing these challenges. Applying the PCN coatings to various elements of a solar cell module, we demonstrate the efficacy of PCNs as gas barriers, corrosion inhibitors, and arc-fault flammability mitigators. I will discuss here not only the results of our studies but also potential mechanisms for effective PCN function and present some apparent limitations of select approaches to PCN integration. These results reveal significant potential for PCNs to impact photovoltaic and other energy-related technologies, and our work highlights how these diverse, highly functional thin films may offer tremendous new opportunities for other next generation materials advances.

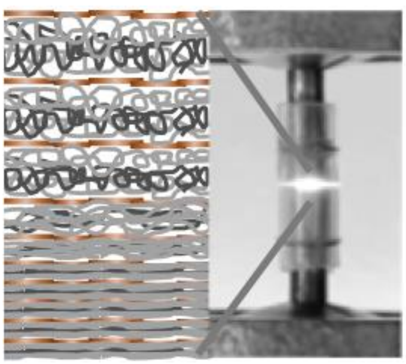

Figure 1 – Left: Illustration of a PCN structure. This coating is applied to a polymer sheath being exposed to a high power electrical arc (right).

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