The interface characteristics of nanomaterials play vital roles in their performances and applications. In the present dissertation, the respective roles of interfaces on the properties, performances as well as potential applications have been investigated regarding two types of nanomaterials.

The electrical and dielectric properties of polymer derived SiAlCN ceramics were studied in a more systematic manner with a focus on the interfacial behaviors. The interfacial characteristics of the polymer derived SiAlCN ceramics was investigated under different testing temperatures via impedance spectroscopy with superimposed dc bias. The results were analyzed through a modified double Schottky barrier model approximating the electronic structure of the material focusing on the role and effects of the interfaces. The resistance and the capacitance of the interfacial phase both reduced with increasing dc bias. The potential barrier height has been found to decrease with rising testing temperatures, whereas the donor concentration increased. These phenomena have been ascribed to the unique bi-phasic microstructures of polymer derived ceramics. The research findings reveal valuable microstructural information of temperature-dependent properties of polymer derived ceramics, and should contribute towards more precise understanding and control of the electrical as well as dielectric properties of polymer derived ceramics.

Furthermore, the desalination performances and underlying mechanisms of two-dimensional CVD-grown MoS2 layers membranes have been experimentally assessed. Based on a successful large-area few-layer 2D materials growth, transfer and integration method, the 2D MoS2 layers membranes showed preserved chemical and microstructural integrity after integration. The few-layer 2D MoS2 layers demonstrated superior desalination capability towards various types of seawater salt solutions approaching theoretically-predicted values. Such performances are attributed to the dimensional and geometrical effect, as well as the electrostatic interaction of the inherently-present CVD-induced atomic vacancies for governing both water permeation and ionic sieving at the solution/2D-layer interfaces.