Surface/interface effect and size/configuration dependence on the mechanical properties in nanoporous membrane

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The objective of this work is to understand the surface/interface effect and the size/configuration dependence on the mechanical properties in nanoporous membranes. The stress concentration, nanopores coalescence, effective elastic moduli, damage level, and contraction or expansion areas are numerically investigated in membrane. It is concluded that the coalescence path of nanopores may appear along the uni-axial tensile loading direction if the size of nanopores is less than 2nm due to the surface/interface effect on the nanopores. Variable arrays of nanopores distributed in membrane can result in the different magnitude of effective elastic moduli. The damage level analysis represented by the M-integral in views of the energy concept reveals that the parallel arrays of nanopores yields the smallest energy release rate due to the self-similar expansion of nanopores. In particular, the nanopores may be contracted even that the remote tensile loading is applied depending on the size of nanopores. These studies present some reasonable explanation of the mechanical behaviors in nanoporous membrane where the mutual or simultaneous influence induced by both the surface/interface effect and the size/configuration dependence.

Keywords: Nanoporous membrane, Nanopores coalescence, Effective elastic moduli, Damage level, Contraction or expansion area