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Hybrid Mixture Theory Based Modeling of Ice-Recrystallization in Frozen Biopolymers Subjected to Freeze-Thaw Cycles

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The frozen food products are subjected to freeze-thaw cycles during storage and shipping. These cycles result in ice recrystallization, surface dehydration, and solute and moisture diffusion, which damage the foods quality. The re-crystallization phenomena involves multiscale characteristics spanning from the scale of polymers to macroscale. The transport of moisture and vapors is complicated by diffusion of solutes governed by Gibbs free energy gradients in the matrix. This presentation will discuss the Hybrid Mixture Theory based equations used to model water, vapor, heat and solutes transport. The unsaturated transport equations will be coupled to phase change equations for predicting the crystal growth at nucleation sites. The effect of freeze-thaw cycles on crystal growth, which causes damage to the surrounding matrix will be discussed. For model validation, the predicted crystal growth/decay will be compared to the experimental porosity measured using X-ray micro-computed tomography (CT). The analysis of micro CT images to calculate porosity, tortuosity and pore size distribution will be presented.

References

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