ABSTRACT

The super-porous biopolymer gels have wide range of applications, especially in controlled release of bioactive species, and as 3-D scaffold for tissue harvesting. The performance of these hydrogel films can be enhanced by introducing voids uniformly into the gel matrix through fluidic arrangement. This thesis addresses the making of biopolymer gel film with embedded voids, and diffusive transport of moisture and solute in aqueous phase respectively through such film. Two different types of fluidic device were used. One was conventional T-joint. The other was the "orifice in throat" arrangement, making use of co-flow with a further squeeze of gas thread at the outlet. Aqueous suspensions of two biocompatible polymers (alginate and chitosan) were considered as the continuous phases in separate experiments to generate sub-millimeter bubbles. The bubble generation process and the bubble size were analyzed under a microscope, and were further studied through mathematical model. The bubble size linearly varied with gas to liquid flow ratio. The bubbles self-aligned after collection on a petridish. The bubble pinch-off from in a T-joint by the geometry-driven collapse (squeeze mode) was developed, and validated using glycerol-water solution. The transition from one mode of pinch-off to the other mode is discussed with reference to the capillary number and the confinement. The bubble generation in the "orifice-in-throat device" was numerically simulated in Ansys for different gas to liquid flow ratios. The bubble diameters from the simulation are compared with experimental observations.

To study the transport of solute in aqueous phase, the vacuum-dried film was soaked in Vitamin B_{12} solution. The porosity of the gel was measured gravimetrically. The release of Vitamin B-12 in PBS buffer on a shaker was studied. The release experiments were repeated at an elevated temperature of 37 °C in the presence of lysozyme. An effective diffusion coefficient within the gel layer, and the mass transfer coefficient at the interface with the bulk-liquid were estimated using a mathematical model. The simulations of solute profile were also performed using a multi-domain approach, assigning different diffusivity values to the void and the gel matrix respectively for comparison.