Thesis title: Microfluidic Engineered Polymer Nanovehicles for Drug Delivery

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ABSTRACT

A key challenge in the production of polymer nanovehicles for drug delivery is obtaining reproducible monodisperse nanovehicles with a minimum number of preparation steps. This research investigates the preparation of polymer nanovehicles using a microfluidic engineering device (the V-shaped microfluidic junction - VMJ) as a one-step processing method to produce polymeric drug carriers in various geometrical configurations (sphere and capsule) along with unique surface features. Firstly, solid polymer nanospheres with contrasting size and surface roughness were prepared using a VMJ device, by dissolving polymethysilsesquioxane (PMSQ) polymer in a range of solvents (methanol, ethanol, propanol, butanol), separately and then subsequently collecting the nanospheres in distilled water at two different temperatures (23°C and 100°C). The study established that size and surface features are directly influenced by the solvent used and temperature of collection. Interestingly, Evans blue coated nanospheres with a rough surface morphology exhibited superior release kinetics when compared to those with a smooth configuration. Secondly, high-speed camera imaging along with advanced microscopy was used to elucidate the method of nanosphere generation in relation to the uniquely tailored surface properties that are conferred through manipulation of concentration and flow rate. Thirdly, monodisperse PMSQ nanospheres with surface adsorbed itraconazole were prepared using the VMJ device. The highest drug encapsulation efficiency of 88% was attained with 120 nm sized itraconazole coated PMSQ nanospheres when compared to 320 nm (74%) and 800 nm (62%) sized nanosphere formulations. Finally, the author intended to prepare amoxicillin-carrying poly (lactic-co-glycolic acid) (PLGA) nanostructures. The PLGA nanostructures were prepared in several geometries including solid nanospheres, porous nanocapsules and hollow shell capsules. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) photomicrographs showed that the bare and

amoxicillin encapsulated PLGA nanostructures had a mean diameter that ranged from 150 – 1200 nm. The nanostructures were also determined to be nearly spherical in shape. The *in-vitro* release studies of amoxicillin from the PLGA nanostructures point to a drug release behaviour that is unique to geometry of the nanostructure. Over a 7 day testing period, the highest release of amoxicillin from the PLGA nanospheres was recorded to be 96 % on day 1. Consequently, it was determined that the release rate diminished but was sustained at 85% for the remaining days. All these findings offer great potential for drug delivery applications and provide new generic insights into the development of advanced drug release systems.