

**UNIVERSITI TEKNOLOGI MARA**

**SYNTHESIS AND CHARACTERIZATION OF POLY (N-  
ISOPROPYLACRYLAMIDE-COPOLYMERISED-ACRYLIC  
ACID) POLY(NIPAM-*co*-AAc) NANOGEL**

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## ABSTRACT

Poly(*N*-isopropylacrylamide)(polyNIPAM) is one of the most well known smart polymers with thermoresponsive behaviour. The cross-linked polyNIPAM exhibits a conformational transition in the form of volume collapse in the range of 32 – 34°C in an aqueous solution, below which the polymer particles are hydrophilic and above which they become hydrophobic. From the point of view of potential applications, the polymer would be useful as a drug carrier if they could respond to multiple stimuli simultaneously. In the work described here, a hydrophilic monomer, acrylic acid (AAc), was copolymerised into the polyNIPAM to obtain poly(NIPAM-co-AAc), a polymer that is responsive to both, external pH and temperature stimuli. The particle size, thermal and pH-responsive properties, zeta potential, heat capacity of the particles in an aqueous solution and morphology were investigated. The results suggested that the synthesized poly(NIPAM-co-AAc) by the surfactant-free emulsion polymerisation (SFEP) technique produced particles of micron scale (25 µm). Additionally, the particles were not significantly sensitive to temperature and pH stimuli. Its lower critical solution temperature was found to be 30°C, which is lower than the control (polyNIPAM). In conclusion, the SFEP technique and the purification method acquired have to be optimised in order to obtain multi-sensitive polymer particles of submicron size.

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# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Nanotechnology is one of the signature fields in science. The technology involves design, characterization, production and application of structures, devices and systems by controlling the shape and size of matter at nanoscale range. It is an exciting area of scientific development which has potential to be used in various fields such as medicine, foods, textiles and cosmetic sciences. However, in order to design materials of nanometer scale, many factors need to be considered due to their various chemical, physical or biological properties.

In the development of pharmaceutical products, polymeric nanoparticles are mostly investigated for their ability to act as carriers in enhancing drug delivery to the target site in the human body. In order to be considered as polymeric nanomaterials for pharmaceutical purposes, the diameters of particles are often ranging from 10 – 1000 nm.

Homopolymer, polyNIPAM is one of the most well-established “smart” polymers in the polymer science field. NIPAM is the major building block for this polymer network which exhibits a unique temperature-dependent conformation. In the work described here, a hydrophilic monomer (AAc) was copolymerized into the polyNIPAM to obtain poly(NIPAM-co-AAc), a polymer that is expected to be responsive towards temperature and pH stimuli. The primary aim of this study was to