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Interfacial Properties of Biodegradable Drug Carrier Nanoparticles

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1. Introduction

Nanomedicine and nano scaled delivery systems are rapidly developed fields of science where materials in the nanoscale range are employed to serve as means of diagnostic tools or to deliver therapeutic agents in a controlled manner. These systems have several advantages compared to traditional techniques. Due to their small size, they can increase the bioavailability of active substances or enable the access of various parts of the body. Another advantage of nano delivery systems is that targeted drug delivery can be achieved via surface modification of particles.

Poly(lactic-co-glycolic acid) (PLGA) has proved to be an excellent material for nanoparticle fabrication due to their controlled and sustained release properties, low toxicity and biocompatibility. The nanoparticles interact with various interfaces in the body before they reach the targeted site where the release of active substances will occur. Therefore, it is important to investigate the interfacial properties and stability of these systems. Another field, where previous interfacial studies are essential is the preparation of nanoparticle stabilized emulsions. The application of PLGA nanoparticles in this field presents an opportunity to prepare pharmaceutical emulsions with great stability.

In this study, the interfacial properties of surface modified PLGA nanoparticles were investigated with optical contour analysis instrument, Langmuir balance technique and atomic force microscopy. Amphipathic, PEO-PPO-PEO, triblock Pluronic copolymer (F127) was used for surface modification to enhance stability. Effects of particle concentration, electrolyte concentration and temperature on the interfacial adsorption of particles were investigated. To gain structural information on the forming adsorption layers at the air-water interface Langmuir and AFM techniques were employed.

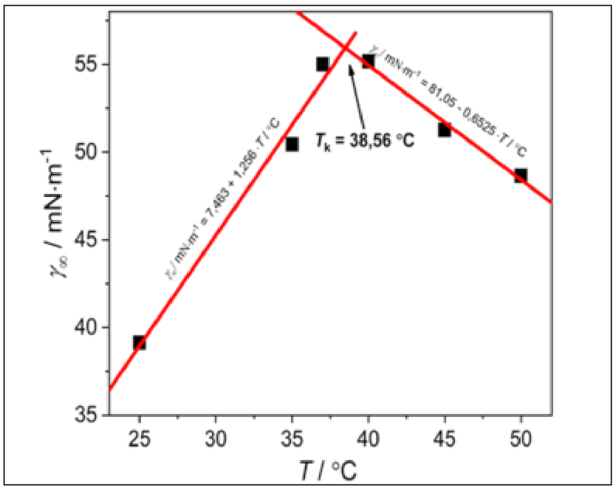

Figure 1 *Temperature dependence of equilibrium surface tensions*

2. Results

The nanoparticles were prepared using the nanoprecipitation method. The prepared systems had an average diameter of 150 nm with a narrow size distribution and –23.6 mV electrophoretic potential.

The effect of particle concentration on nanoparticle adsorption

Optical contour analysis was used to investigate the effect of particle concentration (c_{PLGA}) on nanoparticle adsorption at the air-water interface at 25 °C. The equilibrium surface tension (γ_∞) was similar in the examined concentration range. Similar concentration independence was found at higher temperatures and in the presence of electrolyte (Table 1). This suggests the irreversible ad-

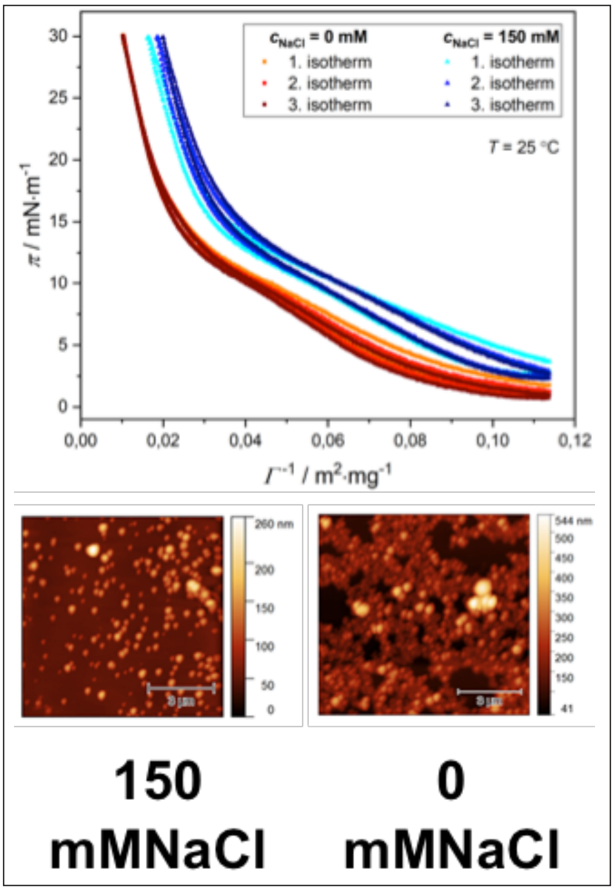

Figure 2 *Langmuir isotherms of PLGA-F127 nanoparticles at 0 and 150 mM NaCl (on the top). AFM images of PLGA-F127 layers at 25 mN·m-1 surface pressure (on the bottom)*

sorption of nanoparticles in the air-water interface.

Table 1 *Concentration dependence of equilibrium surface tensions*

c_{PLGA} / g·L^{-1}	0.25	0.50	1.00	2.00	3.00
γ_∞ / mN·m^{-1}	38.03	38.57	39.14	39.16	38.02

The effect of temperature on nanoparticle adsorption

A method was developed to investigate the adsorption of nanoparticles in the 25 °C to 50 °C temperature (T) range.

Equilibrium surface tension values (γ_∞) were determined from the measured surface tension (γ) vs time (t) curves at various temperatures. A break point was found at 37 °C in the increase of equilibrium surface tensions with temperature (Figure 1). This change was identified as the temperature dependent gelation of the Pluronic layer of the particles at the air-water interfaces.

Langmuir studies and AFM measurements

Langmuir balance technique was also used to investigate the interfacial properties of the nanoparticles. The surface pressure- inverse surface concentrations (Γ) isotherms were determined in the presence of 0 and 150 mM electrolyte at 25 °C (Figure 2).

3. Summary

Surface modified PLGA nanoparticles were prepared and characterized by their interfacial properties. The irreversible adsorption of nanoparticles was observed at the air-water interface. A breakpoint was observed in the temperature dependence of equilibrium surface tension values indicating the gelation of the Pluronic surface modifier. Interfacial aggregation of nanoparticles is also proven to occur in the presence of electrolytes.

The gained results could help in the rational development of drug delivery systems as well as biocompatible and biodegradable Pickering emulsion stabilizers for medical applications.

4. Acknowledgements

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