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Preparation and Characterization of the Polyurethane-Chitinous Composite Packaging Film

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Abstract. Objective: Preparation of the novel material for biodegradable plastic packing. **Methods:** Copolymerization of polyurethane and chitinous is used for preparation the composite packaging films. **Results:** The copolymers of Polyurethane-Chitinous was prepared with Screw extrusion method. Moreover, the oil penetration and *In vitro* biodegradation were employed to characterize the copolymers. **Conclusion:** The results revealed that the introduction of chitinous would decrease the oil penetration, meanwhile, the heat sealability of copolymers can be kept within quality standard range, which were important to the use as the food packaging.

Introduction

With the development of commodity economy, the demand for all kinds of packaging materials has brought a nice business opportunities to packaging industry, however, the traditional packaging materials resulted in serious white pollution, especially, lots of heavy metals and other harmful substances in the packaging materials brought serious environmental problems [1-3]. China, the United States, the European Union developed many relevant laws and regulations or standards for the preparation and application of the packaging materials. Biodegradable packaging materials, such as PLA and PU(polyurethane), were considered to be a promising packaging material[4, 5]. However, the oil sealability can not meet the packaging needs.

The paper aims to design Polyurethane-Chitinous films as food packaging, which can decrease the oil penetration and keep the nice heat sealability.

Experiments and Results

Preparation of Polyurethane-Chitinous Composite Materials. The polyurethane-chitinous was prepared with with Screw extrusion method. First, the polyurethane was synthesized as the Fig. 1. Second, the polyurethane-chitinous particles, in which the ratio of polyurethane and chitinous was shown in Table. 1, were prepared with screw extrusion method. Thirdly, the polyurethane-chitinous particles were blown into the films within the 165-185℃ with blowing machine[6].

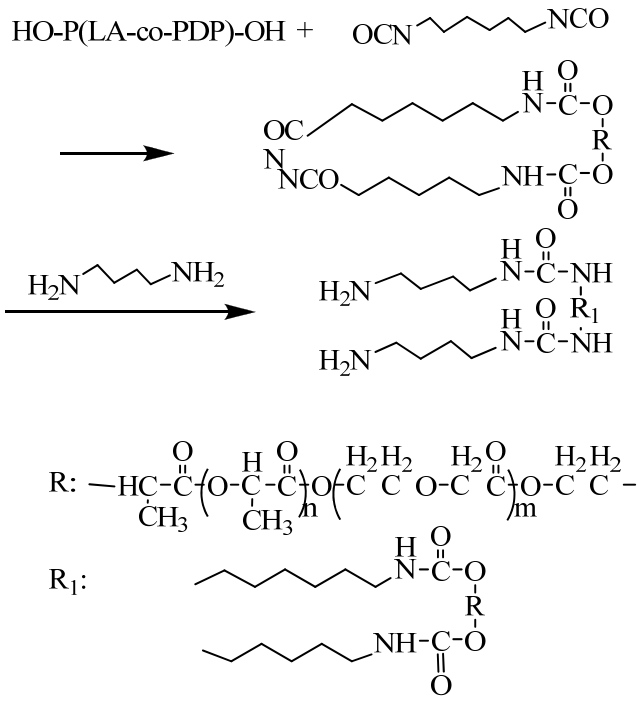

Figure 1. The synthesis route of polyurethane

Table 1. The molar ratio of polyurethane and chitinous (Copolymer) and the thickness of the composite films

Project \ No.	Copolymer1	Copolymer2	Copolymer3
Molar ratio	99.5:0.5	99.0:1.0	98.0:2.0
Thickness(μm)	15	15	15

Surface topography. The microstructure of the composite films, which were pretreated by spray gold treatment, was evaluated by the elepctron microscopy. The SEM images showed that the surface of composite films were uneven, from which we can speculate the phase searation between polyurethane and chitinous. The phase separation increased with the ratio of chitinous, especially, the copolymer 3(ratio of chitinous is 2.0%), which is consistent with the literature 7. From the SEM images, the experimental conditions was determined as Table 1. The composite films were prepared for food packaging, which required the nice oil resistance and heat sealability.

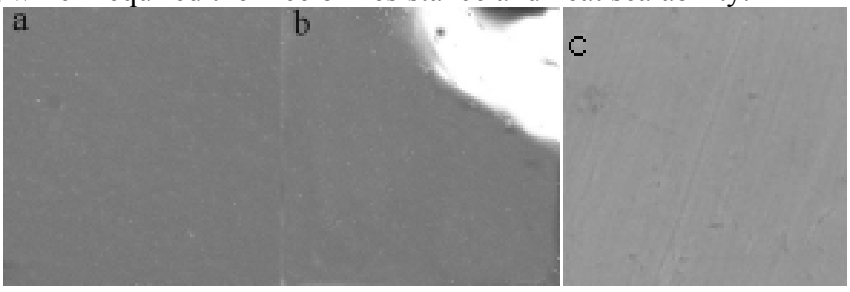

Figure 2. SEM images of polyurethane-chitinous films: a: 99.5:0.5; b: 99.0:1.0; c: 98.0:2.0 (×1000)

Oil penetration and Mechanical experiment. The oil penetration was detected with the soaking method in Fig. 3. 50g edible oil was poured into the plastic bags, from composite films (copolymer 1, 2 and 3) for 30 days. First, the weight of samples (including edible oil and plastic bags) were weighted. Second, the weight of samples after 7, 14, 21 and 30 days.

The results of the oil penetration experiment were shown in Fig. 4. The mechanical stretching and stripping results of oil penetrated plastic bags were showed in Table 2, which meet the national standard[8].

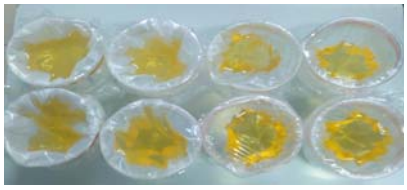

Figure 3. The images of the oil penetration experiment

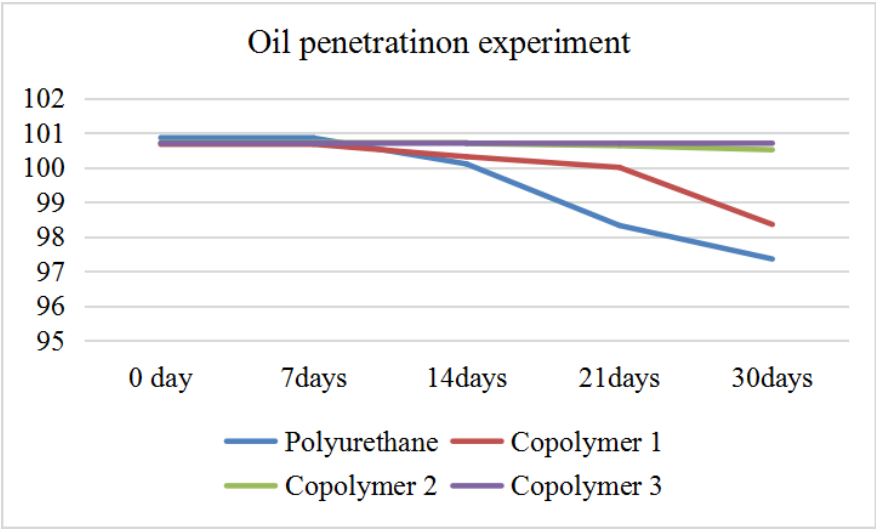

Figure 4. The results of the oil penetration

Table 2. The mechanical stretching and stripping results of after soaking 14days

Sample	Breaking tensile strength（MPa）	Maximum pulling force（N）	Peel strength(KN/m)
Polyurethane	8.22	1.64	0.24
Copolymer 1	8.25	2.48	0.25
Copolymer 2	8.74	10.77	0.21
Copolymer 3	13.46	10.96	0.23

From the results of Fig. 4. and Table. 2, we can find that the oil resistance of copolymers increased with the increasing of the ratio of chitinous. The mechanical stretching and stripping of soaking films showed the same conclusion. The results of the analysis are as follows: the analysis of the tensile strength and the maximum tensile force of the above films showed that the change of the chitinous ratio copolymer film have an important affect on the oil resistance; moreover, with the increase of the ratio of chitinous, the tensile strength and the maximum tensile force of the composite film material are also increased, which can be due to the barrier properties of the chitinous[9, 10].

Conclusions

The results revealed that the introduction of chitinous would decrease the oil penetration, meanwhile, the heat sealability of copolymers can be kept within quality standard range, which were important to the use as the food packaging.

Acknowledgements

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