Study on radiation vulcanization of natural rubber latex*

Zhu Nan-Kang[1], Makuuchi K [2], Yoshii F[2], and Wang Chun-Lei[1]
([1] *Department of Radiation Medicine, Suzhou Medical College, Suzhou 215007;*
[2] *Takasaki Radiation Chemistry Research Establishment, JAERI, Takasaki, Japan*)

Abstract The effect of dose rate of ^{60}Co γ-ray on radiation vulacnization of natural rubber latex is studied using Malaysian latex with 0.002 mass fraction KOH and 0.05 mass fraction n-BA. Results show that, when radiation doses are 20 and 15 kGy, only that the dose rates are greater than 0.49 and 1.6 kGy/h, respectively can make the tensile strength of latex film meet the related standard; besides, storage time of radiation vulcanization latex has no effect on physical properties of the film.

Keywords ^{60}Co, Gamma radiation, Radiation vulcanization, Latex

1 Introduction

The RVNRL(radiation vulcanization of natural rubber latex) aims to produce the latex products with low protein, free of sulfur and N-nitroamine. A series of researches on RVNRL in the world were started from the 1960's.[1-3] Until the 1980's the commercial RVNRL became possible.

The purpose of this work is to investigate the effect of irradiation dose rate and storage time of RV(radiation vulcanization) latex on the physical properties of latex film.

2 Experimental

2.1 Materials

Industrial grade n-BA and analytical grade KOH were purchased from Wako Junyaku Chemical Co. Ltd. The commercial high ammonia natural rubber latex (IOTEX DRC 0.6) from Malaysia was used for radiation vulcanization.

2.2 Process of RVNRL

DRC 0.6 latex was diluted to 0.50 with 0.01 mass fraction ammonia solution. While stirring, 0.002 mass fraction KOH and 0.05 mass fraction n-BA referring to mass of dry rubber were added into diluted latex in turn. Stirring was continued for half hour. Then such latex was exposed to the given dose at certain dose rate in ^{60}Co cell.

2.3 The preparation of RV latex film

The films were prepared by casting RV latex on the glass plate (12 cm×18 cm). The thickness was about 0.8 mm. They were dried in air at 25°C until transparent and then immersed in 0.01 mass fraction ammonia solution for 24 h. The leached films were washed with distilled water and dried at room temperature until transparent again. Thereafter, the films were heated for 1 h at 70°C. After cooling, the films were cut to dumbbell shape and conditioned at 25°C over night.

2.4 Physical property test

The tensile strength and relative elongation at break (T_b and E_b) were examined for the above dumbbell samples by tensile machine.

3 Experimental results

According to the requirements of the

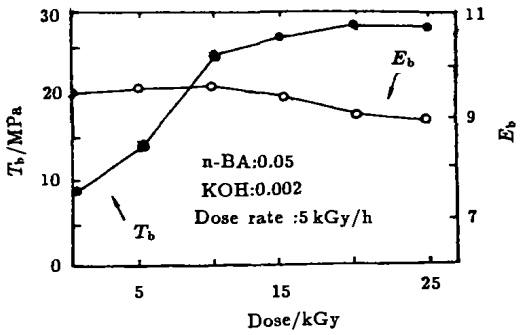

Fig.1 Effect of dose on mechanical properties of RVNRL film

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related standard: T_b > 24 MPa and E_b >7, the optimum radiation doses are 15~20 kGy (see Fig.1). It can be seen from Fig.2 that for radiation doses of 20 and 15 kGy, only if dose rates are greater than 0.49 and 1.6 kGy/h, respectively, then T_b >24 MPa.

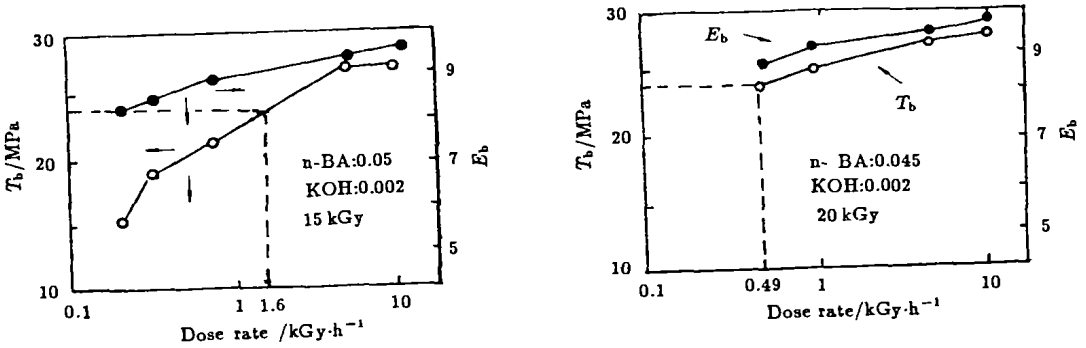

Fig.2 Effect of dose rate on mechanical properties of RVNRL film

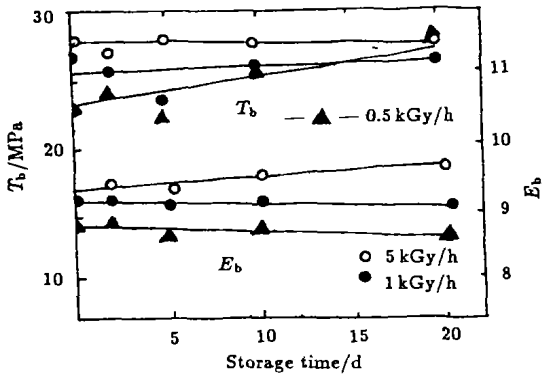

Fig.3 Effect of storage time of RVNRL on T_b and E_b of the films with 0.045 mass fraction n-BA and 0.002 mass fraction KOH (dose:20 kGy)

Additionally, Dr. Wan Manshol[4] found that too longer irradiation time would worsen the physical properties of latex film. It is probably due to the hydrolysis of n-BA in alkaline latex. These results elucidate that during the commercial RVNRL, the dose rate must be greater than the critical value to minimize the possibilities of the hydrolysis of n-BA. After RV latex was stored for 0, 2, 5, 10 and 20 d, T_b and E_b of the films were examined and found that storage time has almost no effect on them. They were even raised with the increase in storage time (see Fig.3).

A number of experimental results show that, if dose rate lowers to a critical value, for example 0.21 kGy/h, even though the exposed dose reaches 35 kGy, the T_b and E_b only have 12.3 MPa and 6.87, less than standard values.

4 Conclusion

For the latex with KOH stabilizer and n-BA sensitizer, at RV doses of 15 and 20 kGy, the critical dose rates must be greater than 1.6 and 0.49 kGy/h, respectively. The physical properties of RV latex film are not changed after 20 days' storage.

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