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Preparation and properties of heat-curable silicone rubber through chloropropyl/amine crosslinking reactions

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HIGHLIGHTS

- A new type of curing system for silicone rubber was studied.
- The new silicone rubber has an excellent mechanical strength.
- The disadvantage in the traditional curing systems can be solved in the new curing system.

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ABSTRACT

A new type of curing system for silicone rubber was studied for the first time by using polysiloxanes containing chloropropyl groups (CPPS) as the gum and poly(dimethyl-co-3-aminopropylmethyl) silicone oil (APPS) or poly(dimethyl-co- 3-(2-aminoethylamino)propyl) silicone oil (AEAPPS) as a crosslinker. The effect of various factors on the silicone rubber was investigated in detail. Better technical conditions were determined and the silicone rubber with excellent mechanical properties was successfully obtained. The tensile strength, tear strength, and elongation at break of the silicone rubber reach 10.25 MPa, 41.87 kN/m, 1365%, respectively. Crosslinking density of the silicone rubber was measured by toluene-swelling method to analyze the crosslinking status. The crosslinking mechanism of the new curing system was also discussed.

1. Introduction

Silicone rubber is one of significant organosilicone products. It exhibits unique performance properties, including biocompatibility, superior temperature and chemical resistance, good electrical insulation properties, and so on. It has been extensively used in many fields such as aviation, electrical industry, medical treatment, and automobile manufacturing [1].

Vulcanization of silicone rubber can be carried out at both elevated and ambient temperatures, and the silicone rubber obtained is called high-temperature vulcanization (HTV) silicone rubber and room-temperature vulcanization (RTV) silicone rubber, respectively [2]. The base gums used for HTV silicone rubber in large-scale application are mainly methylvinylpolysiloxanes with less than 0.5 mol % of vinylsiloxane units. They can be cured at high temperature in two methods by peroxides (Fig. 1) such as 2,5-bis(tertbutylperoxy)-2,5-dimethyl hexane (DBPMH) [3–5] or hydrosilation reaction (Fig. 2). Free radical crosslinking reactions using peroxides as a catalyst produce small molecules which are difficult to remove from the systems and sometimes influence the mechanical properties of the elastomers. For hydrosilation crosslinking reaction, the catalyst chloroplatinic acid is easily to be poisoned [6,7]. Therefore, silicone vulcanizates by peroxides or hydrosilation reaction are limited in some applications.

In this article, the polysiloxanes containing chloropropyl groups were synthesized. By using such polysiloxanes as gums and polyamine compounds as crosslinkers, a new type of HTV silicone rubber by new curing system was obtained for the first time. It is found through initial investigation that the silicone rubber in new curing system has excellent mechanical properties compared with

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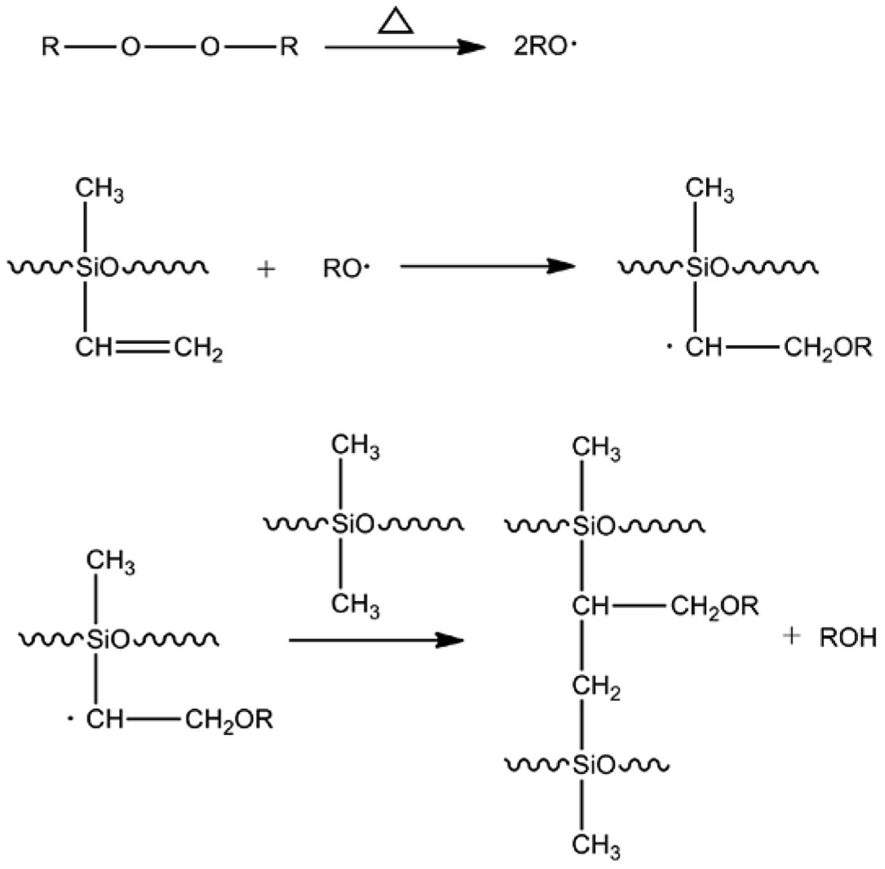

Fig. 1. The curing mechanism of silicone rubber by peroxide.

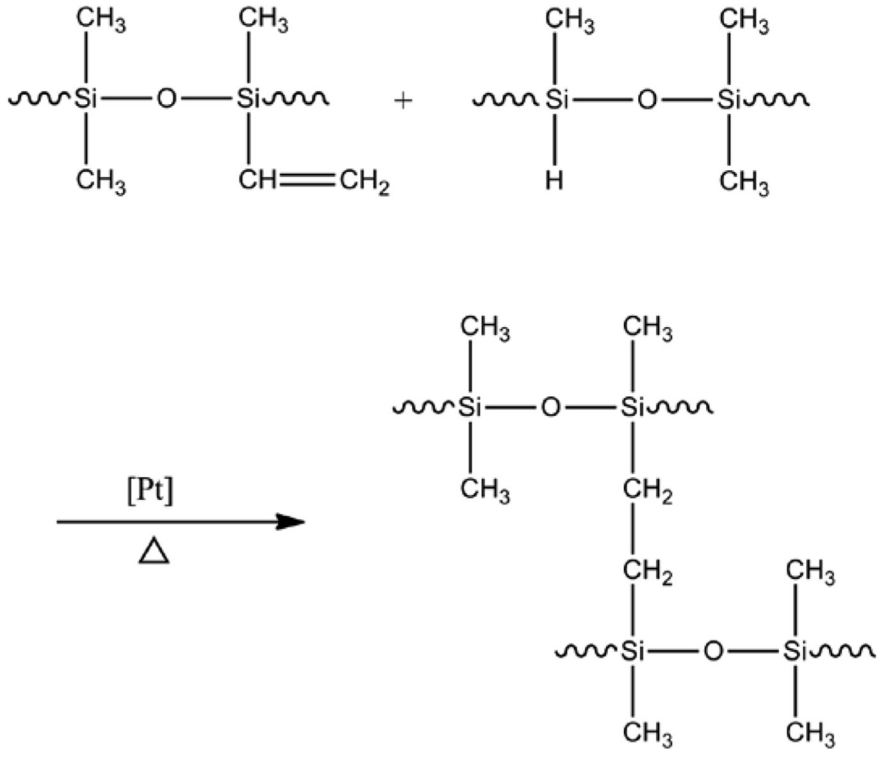

Fig. 2. The curing mechanism of silicone rubber by hydrosilation reaction.