PHYSICAL CHEMISTRY 2012

11th International Conference
on Fundamental and Applied Aspects of
Physical Chemistry

Under the auspices of the
University of Belgrade

Proceedings

The Conference is dedicated to
Professor Ivan Draganić

September 24-28, 2012
Belgrade, Serbia

ISBN 978-86-82475-27-9 ***Volume*** **1**
ISBN 978-86-82475-28-6 ***Volume*** **II**

Title: PHYSICAL CHEMISTRY 2012 (Proceedings)
Editors: S. Anić and Ž. Čupić
Published by: Society of Physical Chemists of Serbia, Studenski trg 12-16, 11158, Belgrade, Serbia
Publisher: Society of Physical Chemists of Serbia
For Publisher: S. Anić, President of Society of Physical Chemists of Serbia
Printed by: "Jovan" Priting and Publishing Company; 200 Copies;
Number of pages: 6+ 497; **Format**: B5; Printing finished in September 2012.

Text and Layout: "Jovan"

200- *Coppy printing*

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F-22-P

THE EFFECT OF GAMMA IRRADIATION ON ETHYLENE PROPYLENE DIENE TERPOLYMER/CHLOROSULPHONATED POLYETHYLENE RUBBER BLEND CURED WITH DIFFERENT SYSTEMS

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Abstract
This work aimed to study the effects of gamma irradiation on the properties of ethylene propylene diene terpolymer/chlorosulphonated polyethylene rubber blend (EPDM/CSM) 50/50 reinforced with 50 phr (parts per hundred rubber) of carbon black and crosslinked either with sulphur/tetramethyl thiuram disulphide or dicumyl peroxide. Irradiation dose rate were 100, 200 and 400 kGy h^{-1}. It was observed that doses higher than 200 kGy practically destroy the assessed properties for all obtained elastomeric materials, irrespective of used curing system. However samples cured with sulphur showed a pronounced decrease in mechanical properties.

Introduction
Polymer blending was recognized in the last few decades as the most promising way to prepare new material with tailored individual properties. Their chemical and physical properties make them suitable as engineering materials, for chemical industry, electric insulators and many other uses [1]. The use of high energy radiation was already proposed as an advanced technique to allow the industrial reprocessing of scrap rubber [2] and in particular IIR. This work aims to study the effects of gamma irradiation on the properties of vulcanized ethylene propylene diene terpolymer/chlorosulphonated polyethylene rubber blend (EPDM/CSM) (50/50) reinforced with 50 phr of carbon black and cured with sulfur and peroxide.

Experimental
For elastomeric materials preparation two network precursors was used: (a) ethylene propylene diene terpolymer (Vistalon 2504), was supplied by Exxon Mobil, France and (b) Chlorosulfonated polyethylene rubber (Hypalon 40S), was supplied by Du Pont, USA; Stearic acid (2 phr) and zink oxide (5 phr) were used as activators of vulcanization. Other materials were added: carbon black, type N550 Degussa, Milan, Italy with a high structure (Dibutyl phthalate (DBP) = 121 ml/100

g) and average size of primary particles (40–48 nm) was used as a filler. Tetramethylthiuram disulphide (TMTD; Bayer, Leverkusen, Germany; 2 phr, magnesium oxide (MgO; Bayer, Leverkusen, Germany; 0.8 phr); Sulphur (Zorka, Sabac, Serbia; 1 phr) and Dicumyl peroxide, (Akzo Nobel, Flexsys Holandia 10phr were used as a curing system for blends.
Compounding was done in accordance with ASTM D 3184-89 using a two-roll mill at room temperature. Cure characteristics were studied using a Monsanto Moving Die Rheometer (MDR 2000) according to ASTM D 2240-93. Tensile testing was carried out with a Monsanto Tensometer M500. Irradiations have been performed in air in the Co-60 radiation sterilization unit with the dose rate of 100, 200 and 400 kGy h^{-1}.

Results and Discussion
Mechanical properties were assessed for rubber mixtures, using curing systems with sulfur and peroxide, as a function of irradiation dose. Results for tensile strength at different irradiation doses were presented in Fig. 1.

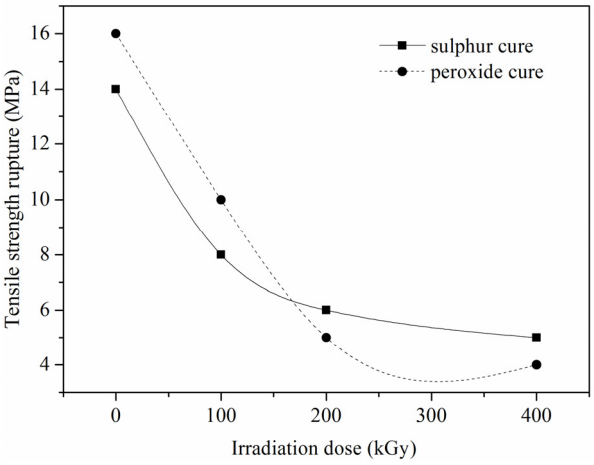

Figure 1. Tensile strength rupture for EPDM/CSM–rubber blend cured with sulfur and peroxide.

The initial stages of degradation of obtained elastomeric materials generally indicate a random breaking of bonds in the polymer chain. In fact, the vulcanized samples with ‘‘sulfur’’ and ‘‘peroxide’’ showed that tensile strength decreases proportionally with the increase in irradiation dose [3]. This decrease was caused by network chain scission. The sample vulcanized with sulfur showed initially a sharp decline in tensile strength even at low doses, probably because of the high flexibility of the tridimensional network structure, due to the presence of polysulfides (C–S–Sn–C), where n>1 [4-5]. At irradiation dose of 200 kGy, the variation of tensile strength for sample cured with peroxide are lower. This is due

to the covalent bonds formed which are shorter and less flexible. When the irradiation dose is increase to 400 kGy, the variation of properties become greather.

Conclusion

The elastomeric materials obtained by different vulcanization systems have quite different sensitivities to irradiation. Sulphur systems influenced no protection of obtained samples against effect of irradiation. The highest degradation occurred in materials prepared by sulfur. It was observed that for low doses the crosslinking was preserved, where for high doses, just degradation process occurred. Samples cured with peroxide were more stable at low doses, as their properties were maintained constant, where–at higher doses they showed severe degradation. At doses higher than 200 kGy there was a major loss observed in the assessed mechanical properties for all elastomers based on EPDM/CSM rubber blends irrespective of the vulcanization system used, except for the samples cured by sulfur.

Acknowledgement

Financial support for this study was granted by the Ministry of Science and Technological Development of the Republic of Serbia (Project Numbers 45022 and 45020).

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CIP Volume I

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

544(082)
621.35(082)
66.017/.018(082)

MEĐUNARODNA konferencija iz fundamentalne i primenjene fizičke hemije (11 ; 2012 ; Beograd)
Physical Chemistry 2012 : proceedings. #Vol. #1 / 11th International Conference on Fundamental and Applied Aspects of Physical Chemistry, September 24-28, 2012, Belgrade ; [editors S.[Slobodan] Anić and Ž.[Željko] Čupić ; organized by Society of Physical Chemists of Serbia ... et al.]. - Belgrade : Society of Physical Chemists of Serbia, 2012 (Belgrade : Jovan). - VI, 498 str. : ilustr. ; 24 cm

"The Conference is dedicated to Professor Ivan Draganić" --> nasl. str. - Tiraž 200. - Bibliografija uz svaki rad.

ISBN 978-86-82475-27-9
1. Društvo fizikohemičara Srbije (Beograd)
a) Физичка хемија - Зборници b) Електрохемијско инжењерство - Зборници c) Наука о материјалима - Зборници
COBISS.SR-ID 193432332