PHYSICAL CHEMISTRY 2010

10th International Conference on
Fundamental and Applied Aspects of
Physical Chemistry

Proceedings

The Conference is dedicated to the
100th Anniversary of the academician Pavle Savić birthday
and
20th Anniversary of the Society of Physical Chemists of Serbia

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21-24 September 2010
B E L G R A D E

ISBN 978-86-82475-17-0
Title: Physical Chemistry 2010. (Proceedings)
Editors: S. Anić and Ž. Čupić
Published by: Society of Physical Chemists of Serbia, Studentski trg 12-16 P.O.Box 47, 11158 Beograd, 218, Srbija
Publisher: Society of Physical Chemists of Serbia
For Publisher: S. Anić, President of Society of Physical Chemists of Serbia
Printed by: "Jovan" Printing and Publishing Company; 200 Copies; Number of pages 16 + 388, **Format:** B5; Printing finished in September 2010.

Text and Layout: "Jovan"

200 - *Copy printing*

The Society of Physical Chemists of Serbia

in co-operation with

Institute of Catalysis, Bulgarian Academy of Sciences

Boreskov Institute of Catalysis, Siberian Branch of the Russian Academy of Sciences

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GAMMA-RADIATION AGING OF SILICA FILLED CHLOROSULPHONATED POLYETHYLENE/ BUTADIENE ACRYLONITRILE RUBBER BLENDS

G. Marković[1], M. Marinović-Cincović[2], S. Samaržija-Jovanović[3], V. Jovanović[3] and J. Budinski-Simendić[4]

[1]*Tigar, Nikole Pašića 213, Pirot, (gordana1markovic@gmail.com)*
[2] *Vinča Institute of Nuclear Sciences, milena@vinca.rs*
[3]*Faculty of science, Kosovska Mitrovica, Lole Ribara 29, (vojani@.sbb.rs)*
[4]*Faculty of technology, Novi Sad, (jarkamer@gmail.com)*

Abstract

In this applicative work curing behavior, mechanical properties and gamma-radiation aging of silica filled elastomeric nanocomposites based on rubber blend: butadiene acrylonitrile rubber (NBR) and chlorosulphonated polyethylene rubber (CSM) were used as network precursors. The vulcanization characteristics were assessed for NBR/CSM rubber blends (50:50, w/w) using oscillating disc rheometer. The gamma radiation resistance of composites was determined from the tensile properties (hardness, tensile strength and elongation at break) after prolonged exposure to γ-irradiation (dose rate of 10 kGyh^{-1} and total absorbed dose of 100, 200 and 400 kGy.

Introduction

One of the most important phenomena in material science is the reinforcement of rubber by particulate fillers, such as carbon black, silica, clays, silicates and others [1-2]. The mechanism of the changes in irradiated polymers includes both the degradation and the cross linking processes. In earlier investigation many authors studied high energy radiation resistance of composites for industrial application [3]. The purpose of the present work was to investigate the influence of silica (with an average particle size of 28 □m) on reinforcement and gamma-radiation resistance of NBR/CSM rubber blends.

Table 1. Formulation of NBR/CSM/silica rubber compounds

Ingredients (phrb)*	Sample 1	2	3	4	5	6
NBR	50	50	50	50	50	50
CSM	50	50	50	50	50	50
Silica (28□m)	0	20	40	60	80	100
Zink oxide	5	5	5	5	5	5
Stearine	2	2	2	2	2	2
Naphtenic oil	10	10	10	10	10	10
Accelerator	2	2	2	2	2	2
Magnesium oxide	4	4	4	4	4	4
Sulphur	1	1	1	1	1	1
Dyethylene glycol	0	0.2	0.4	0.6	0.8	1

***** mass part per hundred mass parts of rubber blend

Experimental

The rubber compounds (Table 1) were prepared by using a laboratory-size two-roll mill maintained at 40±5°C expressed in mass part per hundred mass parts of rubber blend (phrb). All test specimens were compression molded at 160°C during the respective optimum cure time (t_{c90}) determined from the Monsanto Rheometer .The cure characteristics: M_l (minimum torque), M_h (maximum torque), t_{c90} (optimum cure time) and t_{s2} (scorch time) were determined with a Monsanto Rheometer model 100S (Table 2).

Tensile strength was measured at room temperature on an electric tensile testing machine (Zwick 1425) according to ASTM D 412. Hardness was measured using an indentation hardness tester according to ISO7619.

Table 2. The cure characteristics of silica filled NBR/ CSM rubber compounds

Cure characteristics	Samples 1	2	3	4	5	6
Ml (dNm)	8	7	7	6	6	5
Mh(dNm)	25	28	30	34	36	38
□M (dNm)	17	21	23	28	30	33
T_{s2} (min)	5	6	8	10	11	14
Tc90 (min)	23	24	26	26	27	30

Irradiations have been performed in air in the Co-60 radiation sterilization unit at the Vinča Institute of Nuclear Sciences with the dose rate of 10 $kGyh^{-1}$ and total absorbed dose of 0, 100, 200, and 400 kGy.

Results and Discussion

The shorter M_l and higher □M (Table 2) for silica filled NBR/CSM rubber blends than unfilled composites indicated stronger interactions between silica and polymer matrix. According silica surface, the scorch time (t_{s2}) and optimum cute time values (t_{c90}) of silica filled NBR/CSM rubber composites is higher than unfilled. The elasticity and tensile strength were sharply improved, also. It is well known that the mechanical properties of filled rubber composites depend strongly on the degree of adhesion between the filler and the rubber. The prepared samples were subjected to different γ-irradiation doses to estimate their aging behavior. Hardness and tensile strength changing values in %, were determined after gamma-radiated ageing in dose up to 400 kGy (Figures 1 and 2). The obtained values of changing hardness and tensile properties show the dependence on the aging dose and silica content.

Conclusion

Curing behavior, mechanical properties and gamma-radiation aging of silica filled elastomeric nanocomposites based on rubber blend: butadiene acrylonitrile rubber (NBR) and chlorosulphonated polyethylene rubber (CSM) was investigated. The scorch time (t_{s2}) and optimum cute time values (t_{c90}) of silica filled NBR/CSM rubber composites is higher than unfilled. The hardness and tensile strength values were sharply improved. Changing hardness and tensile properties show the dependence on the gamma-radiated aging dose and silica content. The degradation process of polymeric chains during irradiation (chain scission R-R→ R● + R●,low

molecular weight fragments may appear with loss of strength and hardness) also notified.

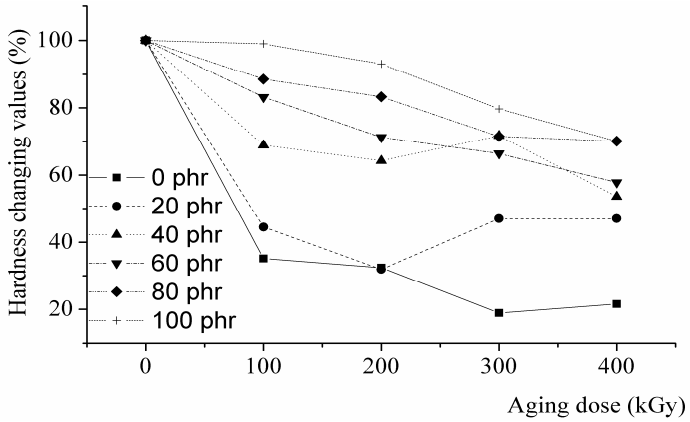

Fig.1 Hardness changing values, %, NBR/CSM rubber blend as a function of the γ-irradiation dose at different concentration of silica.

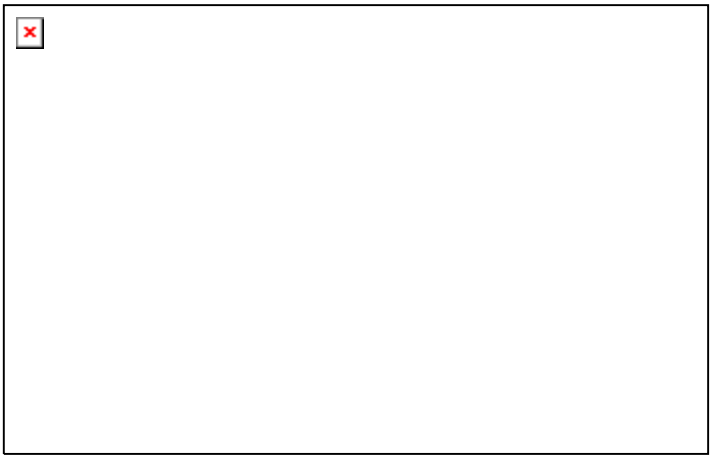

Fig.2 Tensile strength changing values, %, NBR/CSM rubber blend as a function of the γ-irradiation dose at different concentration of silica.

References

[1] P. K. Mallick, S. Newman, Composite Materials Technology: Processes and Properties, Hanser, New York ,1990.

[2] A. Berejka, C. Eberle, Radiation Physical Chemistry, 2002, **63**, 551-558.

[3] R. L. Clough, Nuclear Instruments and Methods in Physical Research B, 2001, **185**, 8-13.