

Dymalink® 633 and Dymalink® 634

Introduce Ionic Crosslinks to Improve Cured Rubber Properties

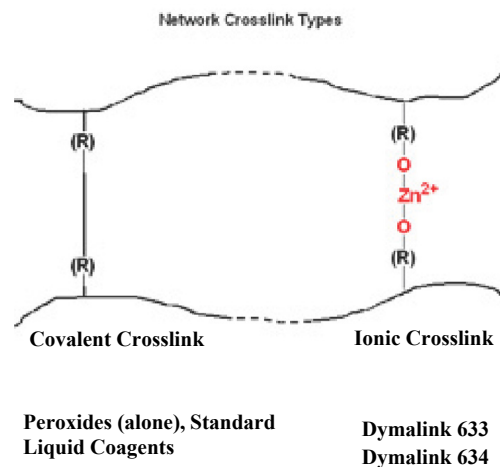


Benefits

- Greater than 40% ionic crosslink density
- Increased modulus and tear strength
- Improved dynamic flex fatigue properties
- Enhanced adhesion to metals and fabrics

Description

The introduction of metallic monomers as coagents in peroxide-cured systems can result in greater than 40% of the crosslinks containing ionic bonds. By using Dymalink® 633 and Dymalink® 634, the benefits of adding ionic character to cured rubber compounds can be realized. These include increased modulus, improved tear strength, increased dynamic flex fatigue properties, and improved adhesion to metals and polar fabrics. The ionic bond is capable of breaking and reforming under strain and can reduce the stresses that would otherwise result in failure of non-reversible covalent bonds. New data quantifies the relative percentage of ionic crosslinks formed in these networks. The experimental results are consistent with the trends in physical property improvements that can be attributed to the ionic bond. The drawing below illustrates the ionic character introduced by Dymalink® 633 and Dymalink® 634.



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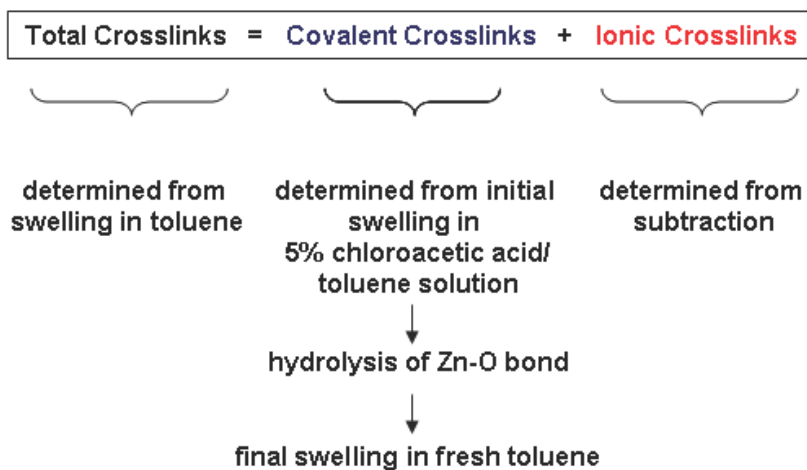
Product features and typical properties of Dymalink®633 and Dymalink® 634 are shown below.

Product Properties			
Product	(Meth)acrylate Functionality	Specific Gravity @ 25°F	Physical Form
Dymalink 633	2	1.598	Wht. Powder
Dymalink 634	2	1.48	Wht. Powder

Analytical Method

An analytical method has been developed that allows for the quantification of the relative number of ionic crosslinks formed in peroxide/metallic monomer-cured networks. Network swelling techniques are first used to calculate total crosslink density. The same system is then subjected to swelling in a weak acid solution that hydrolyses the Zn-O bond, leaving a network supported only by covalent bonds. After calculating the covalent crosslink density from a subsequent swelling step, the number of ionic crosslinks can be determined by subtraction. The figure below describes the procedure.

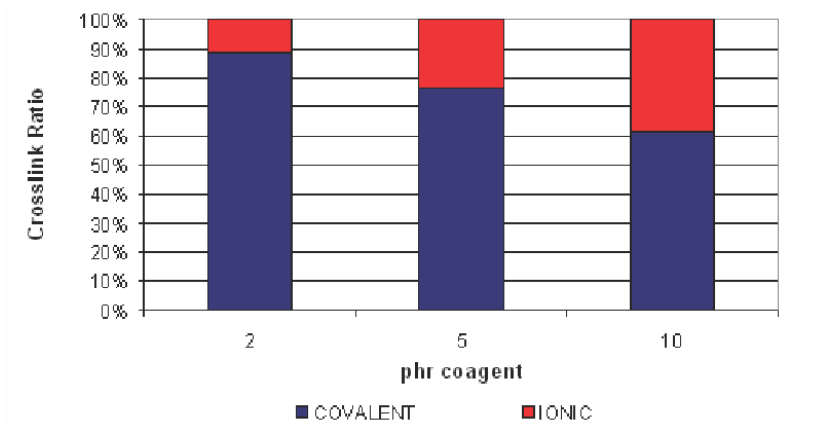
Methodology for Calculating Ionic Crosslink Density



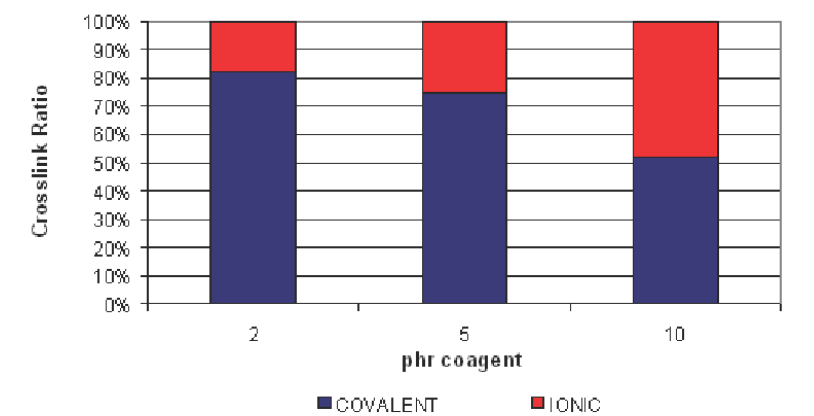
Ionic Crosslink Determinations

Using the above technique, the relative number of ionic crosslinks obtained as a function of metallic monomer coagent loading was determined for a dicumyl peroxide-cured EPDM formulation. Flory-Rhener methodology was used to calculate crosslink densities; toluene was used as the swelling solvent. The results for Dymalink® 633 and Dymalink® 634 are shown below. At low loading, approximately 15% of the crosslinks are derived through incorporation of the metallic monomers, while at elevated loadings, greater than 40% of the crosslinks contain ionic bonds.

Ionic to Covalent Crosslink Ratios Using Dymalink 633



Ionic to Covalent Crosslink Ratios Using Dymalink 634



Application Performance

Metallic monomer coagents have been shown to provide several advantages in vulcanizate properties when compared to standard liquid monomers. The benefits provided by Dymalink® 633 and Dymalink® 634 can be attributed to the ionic crosslink structure. The following EPDM rubber compound formulations were used for adhesion and tear strength testing.

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Experimental Compound	
Ingredient	phr
Nordel™ IP 4640 ¹	100
Carbon Black	100
Sunpar® 2280 ²	50
Zinc Oxide	5
Naugard® Q ³	1

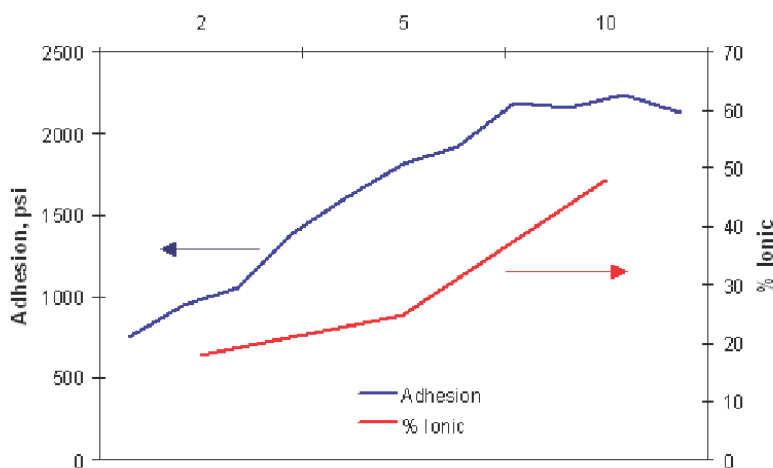
Stage 1: Internal Mixer

Dymalink® 633	variable
Dyamalink® 634	variable
Varox® DCP40KE ⁵	12.5

Stage 2: Two-Roll Mill

1. Nordel is a trademark of Dow Chemical Company
2. Sunpar is a registered trademark of Sunoco, Inc.
3. Naugard is a registered trademark of Chemtura Corporation
4. Dymalink 633 and Dymalink 634 are monomer coagents from Resin Solutions
5. Varox is a registered trademark of R.T. Vanderbilt Company, Inc.

The chart below demonstrates an increase in adhesion between an EPDM compound and steel as a function of Dymalink® 634 loading. Adhesion correlates well to the percentage of ionic crosslinks in the system.

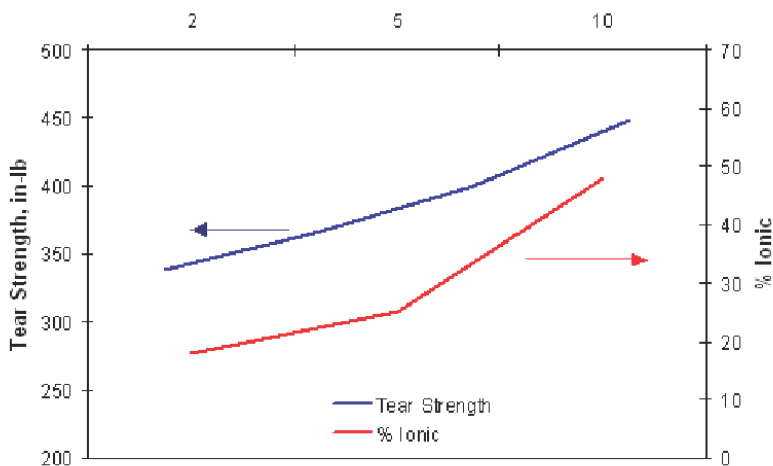


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SR633 & SR634 Introduce Ionic Crosslinks to Improve Cured Rubber Properties



The following figure correlates tear strength and Dymalink 634 loading. Again the increase is attributed to a relative increase in ionic crosslink density.



Benefits Summary

Metallic monomer coagents have been documented to produce performance improvements in rubber applications, including hoses, tires, rubber rolls, sporting goods, and other engineered products. It is now possible to quantify the relative amounts of crosslink density and to correlate these findings with the improvements in properties that are attributable to the central ionic bond.

About Resin Solutions

Resin Solutions is the premier global supplier of specialty chemical additives, hydrocarbon specialty chemical, and liquid and powder tackifying resins used as ingredients in adhesives, rubbers, polymers, coatings and other materials. Resin Solutions has pioneered the development of these advanced technologies, introducing products that enhance the performance of products in energy, printing, packaging, construction, tire manufacture, electronics, and other demanding applications. For more information, please visit www.resinsolutions.com.

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