TECHNICAL UPDATE

CRAY VALLEY
Hydrocarbon Specialty Chemicals

Dymalink™ 633 & Dymalink™ 636
Use of Metallic Coagents in Peroxide-Cured Chlorinated Polyethylene (CPE)

Benefits

- Increased Tensile Strength
- Higher Modulus
- Lower Compression Set
- Comparable Heat Aging

Dymalink™ 633:

- Greater Crosslink Density
- Enhanced Adhesion to Metals

Dymalink™ 636:

- Better Scorch Safety
- Contains no zinc

Target Markets

- Engineered Products (e.g. Belts, Hoses, Tubing)
- Wire & Cable Jacketing

Additional Information

MSDS/TDS: Dymalink™ 633 & Dymalink™ 636

Description

Although peroxide curing of chlorinated polyethylene is a common practice, this elastomer tends to have a relatively low cure state without the addition of a coagent.

Coagents function with the peroxide cured system to modify this C-C network. It has been stated that the coagent homopolymerizes and grafts onto the polymer backbone. These results in several property improvements such as higher tensile and tear strength, modulus, and lower compression set than curing with peroxide alone.

Features and typical properties of the metallic coagents used in this study are shown in Table 1.

Table 1. Metallic Coagent Features and Typical Properties

Product	Description	Features
Dymalink™ 633	Zinc Diacrylate (non-nitroso scorch retarder)	• Off-white powder • Specific Gravity = 1.59
Dymalink™ 636	Calcium Diacrylate	• Off-white powder • Specific gravity = 1.44

Zinc-centered metallic coagents have been used to enhance the properties of peroxide cured networks by imparting an effective mechanism via "ionic" bonding to facilitate reversible chain slippage without sacrificing network integrity. These coagents increase cure rate (scorch safety) and cure state (crosslink density); thus, they usually contain a non-nitroso scorch retarder to prevent premature curing during processing and/or vulcanization. Even though Dymalink™ 633 includes a scorch retardant package, scorch times are still shorter than peroxide alone. These properties are displayed in Figure 1 and Figure 2 shown below.

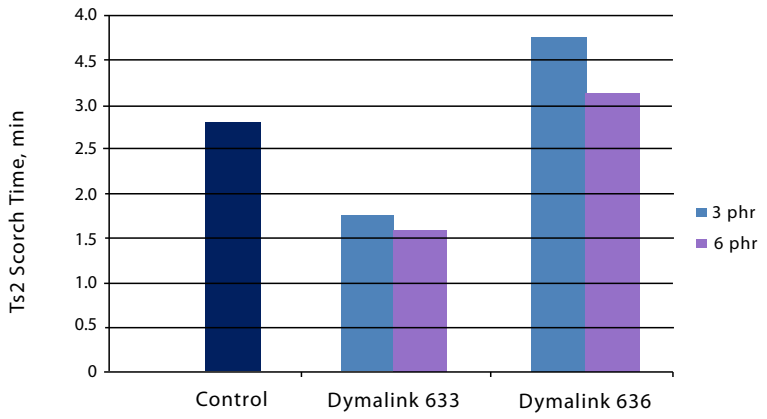

Figure 1. Scorch safety at coagent loadings of 3 phr & 6 phr as compared to the CPE control.

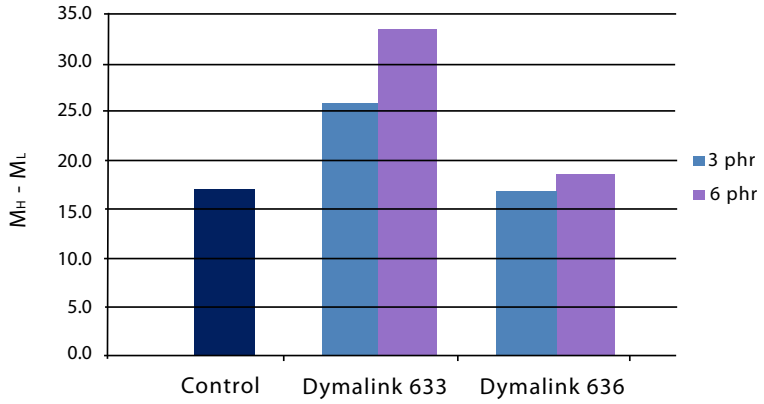

Figure 2. Crosslink Density at coagent loadings of 3 phr & 6 phr as compared to the CPE control.

An increase in tensile strength was observed with the metallic coagents; Dymalink™ 633 demonstrated the greatest increase (3 phr: +37.5%, 6 phr: +50%). These values are displayed in Figure 3 shown below.

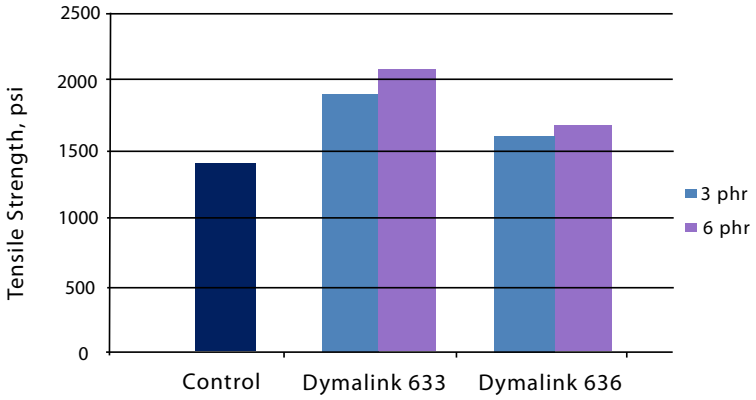

Figure 3. Tensile Strength at coagent loadings of 3 phr & 6 phr as compared to the CPE control.

An increase in modulus was observed with the metallic coagents; Dymalink™ 633 demonstrated the greatest increase (3 phr: +52%, 6 phr: +76%). These values are displayed in Figure 4 shown below.

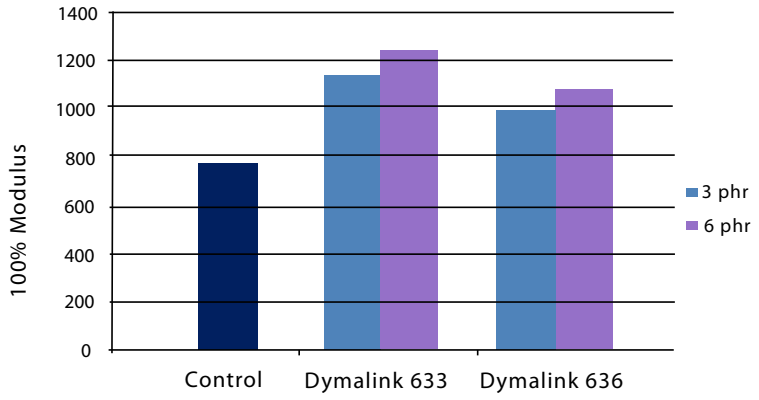

Figure 4. Modulus at coagent loadings of 3 phr & 6 phr as compared to the CPE control.

Although peroxide cured compounds typically have low compression set values compared to sulfur cured systems, the CPE control in this study had a rather high compression set (78%). The metallic coagents improved compression set performance by 15% - 20% as displayed in Figure 5 shown below.

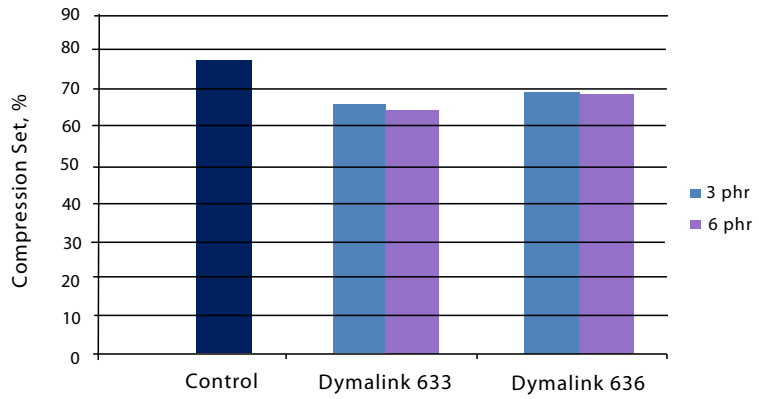

Figure 5. Compression set at coagent loadings of 3 phr & 6 phr as compared to the CPE control.

Due to its "ionic" bonding, Dymalink™ 633 produces extremely strong rubber-to-metal adhesion without the use of external additives. These adhesion values are displayed in Figure 6 shown below.

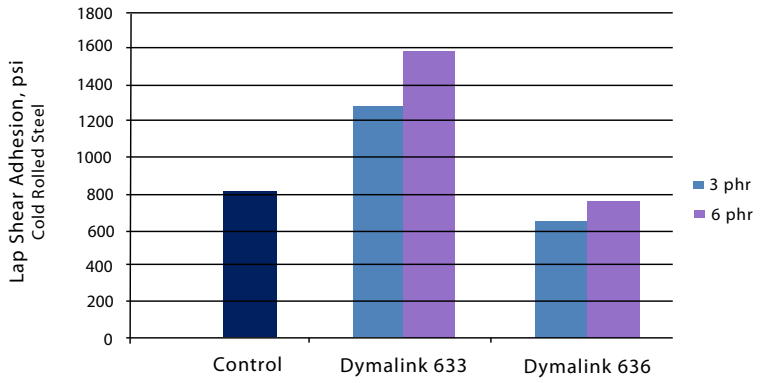

Figure 6. Adhesion at coagent loadings of 3 phr & 6 phr as compared to the CPE control.

Summary

It has been shown that metallic coagents provide additional crosslinking in peroxide cured CPE compounds. This leads to an improvement in tensile strength, modulus, compression set, and other performance properties. Dymalink 633 also act as an adhesion promoter. Dymalink 636 is an effective zinc-free metallic coagent.

Appendix

Table 2. Model Formulation	
Ingredient	**phr**
CPE (Tyrin™ CM0136)	100
Carbon Black (N550)	60
Calcium Carbonate	40
Di-isodecyl Phthalate (DIDP)	30
Magnesium Oxide (Maglite® D)	5
Antioxidant (Agerite® Resin D®)	
Dicumyl Peroxide (Di-Cup® 40KE)	7
Coagent	0, 3, 6

Tyrin™ is a trademark of Dow Chemical Company
Maglite® D is a tradename of Hallstar
Agerite® Resin D® is a tradename of R.T. Vanderbilt Company
Di-Cup® 40KE is a tradename of Arkema Inc.

Table 3. Test Methods	
Test Description	**ASTM Designation**
Cure Characteristics (ts_2, M_L, M_H)	D2084, ODR:160 °C, 3° arc
Tensile Strength, Modulus	D412, Method A, Die D
Compression Set	D395
Lap Shear Adhesion	D814

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