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# CARILON™ Thermoplastic Polymer Blends

Binary and Ternary Blends of  
CARILON Polymer and  
Polycarbonate. Binary Blends of  
CARILON and Various Soft Polymers:  
Initial Results

W. P. Gergen, D. G. Waters, R. P. Gingrich

Technical Progress Report WRC 45-88  
Project No. 62182

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# **CARILON™ Thermoplastic Polymer Blends**

## **Binary and Ternary Blends of CARILON Polymer and Polycarbonate. Binary Blends of CARILON and Various Soft Polymers: Initial Results**

### **Technical Progress Report WRC 45-88**

Project No. 62182  
CARILON Polymers – ETP Applications

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#### **SHARED**

*Under the Research Agreement between SIRM and Shell Oil Company dated January 1, 1960, as amended.*



## ABSTRACT

A review of the progress to date on binary and ternary blends of CARILON™ polymer and polycarbonate and binary blends of CARILON polymer and various soft polymers is presented. Experimental details, physical properties, rheology, and electron microscopy results are reported. Key conclusions are that polymers that are miscible with CARILON polymer generally increase the rate of rise of melt viscosity; immiscible blends have only a moderate effect on rheology. Those polymers that strongly interact (*i.e.*, increase the rate of rise of viscosity) appear to facilitate IPN formation in blends with polycarbonate. There is only a slight indication of CARILON polymer miscibility with polycarbonate from this study even though analog calorimetry predicts miscibility. Thermoplastic elastomers as a class appear to be effective impact modifiers; good interfacial adhesion and correct particle morphology is key to impact improvement.

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Technical Progress Report WRC 45-88

# **CARILON™ Thermoplastic Polymer Blends**

## **Binary and Ternary Blends of CARILON Polymer and Polycarbonate. Binary Blends of CARILON and Various Soft Polymers: Initial Results**

by

**W. P. Gergen, D. G. Waters, R. P. Gingrich**

### **INTRODUCTION**

The objective of the current CARILON Polymer blending program at WRC includes the development of a basis for a strong and aggressive patent position, discovery of leads which might lead to useful stabilization schemes, and the exploration of the property sets accessible by blending with other polymers. Potential blending components are chosen on a technical basis, *i.e.*: compatibility, potential for strong interaction or reaction, processing window accessibility; on the basis of potential property development; and on the basis of commercial availability of the components and commercial saleability of the products.

The market for polymer blends is quite varied and suggests an organizing philosophy or categories of blends based on the nature of the components and the type of property modification that is accomplished in the blend. This grouping: 1. Amorphous-amorphous, 2. Crystalline-amorphous, 3. Crystalline-crystalline, and 4. Rubber-toughened blends, reflects the nature of the constituents and immediately brings to mind also the impression of the kind and level of property modification possible with these combinations of constituent types. Examples of blends which are presently in the market-place in the most important category, where we find the most complementary property improvements coming from each constituent, are shown in Table 1.

Examples of commercial blends which are also of interest to us especially in fiber-filled blends where the biggest need is to restore the impact loss resulting from the matrix stiffening

by the fiber, are listed in the two categories shown in Table 1.

Our blend program, at least to some extent, follows these categories and certainly follows the lead of these commercial blends. We have established a priority of components to use in our blending program which emphasizes the commercially available amorphous resins; polycarbonate (PC), polyphenyleneoxide (PPD), amorphous nylon (ANY), polyarylsulfone (PS), and ABS. With CARILON EP polymer as the crystalline phase, we have a chance of developing an interesting set of performance properties in these blends. We need to provide the best possible adhesion in these blends and it will be necessary to maintain the lowest possible interfacial tension to achieve a useful morphology in these polymers and so we include in the same program polymeric components which may be capable of lowering the interfacial tension between the amorphous and crystalline phase and which also may act as impact improvers for the ternary system. These are generally selected from the known examples of relatively polar rubber-like polymers.

Finally, we have learned by a great deal of experience with polymer blends of this type, that we need to be able to develop co-continuous morphology, or IPN's, so that both the properties of the crystalline phase as well as those of the amorphous phase can be expressed and combined effectively in the blend. In addition to these very targeted objectives and strategies of the blends program, we will continue to screen other polymers with CARILON EP polymer to broaden the scope of our total CARILON blends

technology and improve our patent position. To that end, we are using the results of analog calorimetry which develops information about polymer interactions using small-molecule model compounds of the blend constituents.

A quite extensive screening was done by R.G. Lutz (*et al*) wherein various polymers were blended with a CARILON EP polymer of relatively high LVN (>2.1) at a level of 10%v, on a twin-screw mixer (Baker-Perkins 15 mm) from powder mixes of the components. The feed-rate during constant power extrusion was monitored (expressed as a feed rate ratioed to the control) to estimate the effect of the component as processing aid, lubricant, or melt stabilizer. The nature of the interaction between components was judged on the basis of STEM photographs of the blends and by DMTA scans which showed shifts occurring in the BETA transition (or in Tg). Some of the blends screened were shown by these methods to be miscible and this was later predicted by analog calorimetry. The blends were compression molded into films of about 0.7mm in thickness for tensile and ZGL impact tests and for oven aging to determine long-term stability. The results of these tests were reported in previous (1987) R&D Notes (January 1987 and May 1987). We have adopted the same or very similar methods to access our blends and in addition we have run Rheometrics tests on the previous blends of Lutz as well as these new blends.

Partial results of the polycarbonate binary and ternary blends as well as the binary blends of the polymers used as "compatibilizers" or impact modifiers have been previously presented at the CARILON Experts Meetings or at CARILON Applications Meetings and are reported here for the sake of permanent and complete documentation as well as interpretation.

## DESCRIPTION OF THE BLEND COMPOSITION, COMPOUNDING, AND PROPERTIES

### DYNAMIC RHEOLOGY OF THE PREVIOUS R. G. LUTZ BLENDS

Subsequent to the work on these blends which was previously reported, we measured the

dynamic viscosity/time curves of those samples in the series for which we had retained samples using the Rheometrics parallel plate test at 275°C which has also been previously described. The data are presented in a composite plot in Figure 1. We will defer discussion of these data until all of the data is presented.

### BINARY BLENDS OF CARILON EP PK087/002 AND "COMPATIBILIZER" POLYMERS

The blends described in Table 2A were made with 90% PK087/002 and 10% Polymer "X". All blends contained the MDU stabilizer package and an additional 0.3% A0330 based on the CARILON EP. Blends were made from CARILON nibs and Polymer "X" nibs after drying 16 hours at 50°C. The blends were compounded on the 30 mm HAAKE twin-screw extruder with a profile temperature range of 95-200-218°C going from feed to nozzle (these runs were made at a time when the barrel of this machine was damaged in the first stage so the profile was chosen to avoid melting in the first zone). The extruder was operated at a constant speed of 200 rpm and the feed-rate and torque were both varied to produce a successful extrusion.

These blends were injection molded on an ARBURG 14 gm machine with a temperature profile 225-240-245-245°C feed to nozzle, with screw rpm of 400, 100 psi back pressure and mold temperature of 58°C. The injection molding speed and pressure which relate to the rheology of the blends is shown in the following along with Izod impact measured on these moldings and ZGL (zero-gauge-length) impact and tensile strength determined on thick films are given in the following Table 2B.

Thick films, (ca 0.75 mm), and thin films (0.25 mm) were prepared from nibbed blends by molding between dry acetone-washed aluminum foils at 250°C for 30 seconds at zero pressure, 30 seconds at 10 ksi, and then 30 seconds at 20 ksi followed by rapid quench between 12.5 mm aluminum plates. Samples were then taken from these films for ZGL and for Rheology.

The nibs from this series of blends were microtomed obliquely to the strand axis and stained with osmium or ruthenium tetroxide to produce the STEM micrographs show in



Figure 2. The rheology data for this series of blends, dynamic viscosity as a function of time, is given in Figure 3.

### **BINARY BLENDS OF CARILON EP PK087/002 AND POLYCARBONATE**

The polycarbonate used in this series (CB1) was Merlon M40 or Makrolon M40 from Mobay. AO level of 0.3% A0330 was used again based on the amount of CARILON EP polymer in the blend. The method of granular mixing was the same as for the previous (CB3) series, the extrusion was the same except for the temperature profile, 220-190-220 feed to die. The series CB1 was based on CARILON PK 087/002. The series CB5 contains binary blends which are based on PK 087/006, LVN=1.83, considerably higher than PK 087/002. Series CB5 also contains blends based on PK 087/002 and mixed on the BP 15 mm twin-screw machine. The composition and extrusion data is presented in Table 3A.

The blends of Series CB1 had poor melt strength and were difficult to strand for that reason. This is not true of blends based on the higher LVN 087/006 polymer. The methods of injection molding and film preparation were the same as for Series CB3 described previously. All testing followed also the previously described methods. The injection molding data is not listed in the following table, all of the CB1 Series samples showed exceptional injection molding response, the injection pressure increased monotonically from about 40 bars for the neat CARILON polymer to 60 bars for the PC M-40 sample, melt temperature was 250°C for all blends and 260°C for PC M-40, injection time was 5 seconds. The property data for the CB1 and CB5 Series is shown in Table 3B.

The DMTA scans were made from -120 to +150°C and showed no evidence of miscibility on the basis of shifts in the beta transition or in the polycarbonate transition. They did show the large difference in the rate of falloff in the modulus with temperature on these quenched films. This is shown graphically in Figure 4 for the CB1 Series blends. The dynamic viscosity versus time relationship was measured on these blends in the previous mentioned manner on the Rheometrics apparatus. The data for the CB1 polycarbonate binary series is shown in Figure 5, the data for the comparison between

the 15 mm BP mixer and the 30 mm Haeke mixer are shown in Figure 6 (no difference), and the comparison at 15% PC M-40 between blends based on PK087/002, the 1.3 LVN polymer, versus blends made using PK087/006, the 1.8 LVN polymer are shown in Figure 7 (significant difference).

### **TERNARY BLENDS OF CARILON EP PK087/002, POLYCARBONATE AND POLYMER "X"**

A composition of 45/45/10 was used in the ternary CB2 Series blends, which were mixed in the same manner as the previous binary series blends. Again an additional 0.3% A0330 was added based on the CARILON EP Polymer content. In every case the extrusion was difficult due to the presence of what appeared to be gels and from strand breaks. The identity and extrusion conditions of these blends are given in Table 4A. Injection molding of the dried nibbed compound was easily accomplished on the Arburg molder using condition similar to those used with Series CB3 show previously. Impact properties are given in Table 9B.

Films for STEM and rheology were prepared in the same manner as above. The composite plot of the dynamic viscosity versus time for this Series is shown in Figure 8.

During the course of this series and Series CB3 it was noted that there appeared to be a significant processing advantage for blends containing maleated polybutylene (Blends CB3I and CB2I). Subsequently, R. L. Danforth examined this effect in very high LVN CARILON polymers and noted a similar phenomenon. To test this we prepared blend Series CB4 which consisted of 1% and 10% of the maleated polybutylene in both PK 087/002 and in PK 087/006. The rheology is shown for these blends in Figure 9.

## **DISCUSSION**

### **TENSILE STRENGTH AND IMPACT PROPERTIES OF ALL BLENDS**

Figure 10 and 11 compare the Izod Impact measured at room temperature and at -20°C on these several blend series. Of the components used as impact modifiers and compatibilizers, the most effective are the thermoplastic

elastomers, KRATON® block copolymer KG-1652 and KG-190IX, the ESTANE polyester and polyether TPUs, the HYTREL polyether-polyester block copolymer, and the PEBAX polyether-polyamide block copolymer. There is a very strong effect of the CARILON base polymer molecular weight which we will describe with the current theory of impact modification in a later report. The impact in these materials is very sensitive to the morphology which was achieved in the mixing. In the low LVN base polymer, as seen in Figure 2, the size of the inclusions was very broadly distributed in most of the samples and was much better in a higher viscosity CARILON polymer. Both the impact and the strength of these blends were very sensitive to the level of interfacial adhesion which can be estimated from the sharpness of the STEM image at high magnifications. The high impact achieved in the maleated PB blend is a result of the high LVN of the 087/006 base polymer. The two impact values at 1% are compared in the two different base polymers and are quite significantly different. We defer further discussion of this point to the later report.

#### DMTA MODULUS VERSUS TEMPERATURE (FIGURE 4)

The most sensitive area for the CARILON EP material outside of the problems associated with the stability of the basic chemical structure, is the decreased modulus which comes as a result of the decrease in crystallinity (introduction of C3 = defects in the chain) and the prominent drop-off in modulus or stiffness as temperature is increased. Both of these factors lead to a lowering of the heat distortion temperature or to the deterioration of load-bearing properties as temperature is increased even slightly. This effect is shown dramatically in Figure 4 where the modulus measured as the real component of the dynamic modulus on the DMTA apparatus is expressed as a linear ratio of the value at 0°C. This characteristic is a common one to many partially crystalline resins, e.g., nylon, polyester, and polypropylene. It is aggravated in CARILON EP polymers and to some extent in CARILON E polymers by the magnitude of the BETA transition which occurs somewhere around room temperature. On the other hand, rigid amorphous resins like polycarbonate do not show such large drop-offs with

temperature as seen in the upper curve of this plot. An IPN of CARILON polymer and polycarbonate would have a contribution similar to those seen in the 60% or 80% polycarbonate curves in this figure and would greatly ameliorate the problem with this transition in a manner similar to that of polycarbonate IPN's with KRATON G polymers where the styrene glass transition is obscured by the continuous polycarbonate phase. The IPN structure offers the hope of achieving a substantially higher HDT in non-reinforced polymer systems.

#### RHEOLOGY OF ALL THE BLENDS (FIGURES 1, 3, 5-9)

A general finding of this work is obvious from the data of blends that were made by Lutz and are presented in Figure 1. Those polymers which are found to be miscible (and predicted to be by analog calorimetry) have the fastest viscosity rise with time. This is evidence of the strong interaction either present or developing with time that is actually promoting a network structure, or a chemical reaction that is leading to a crosslinked structure. The group contains the blends of EPONOL and polyvinylphenol. The second strongest interaction is the blends with PBT and with TPU (polyester based) which have a slower rate of rise in viscosity but still substantially greater than the control or the non-interacting components, PVDF, ZN-SURLYN, SAN, NYLON 6, Polymethylpentene, and EVAL F. Of these latter polymers, only the polymethylpentene and EVAL F have been modeled by analog calorimetry and predicted to be non-interacting.

The picture is continued in Figure 3 where the SERIES 3 blends are shown. The legend in this figure is arranged in order of increasing interaction, judged by the increasing rate of viscosity rise. Notice that all of the thermoplastic elastomers which were found to be the most effective in raising the impact of 087/002 show the highest interaction, and that the TPU blend agrees well with the different TPU blend in Figure 1. The only material that showed a viscosity rise lower than the control was Zn-Surlyn. This finding was responsible for our later tests of this polymer as a melt-processing stabilizer in a "Show-Down" experiment which will also be described in detail in a later report.

The binary blends with polycarbonate are shown in Figure 5A and B. The important feature is that the addition of polycarbonate increases the rate of viscosity rise, indicating that there is at least some interaction with the CARILON polymer. At levels above 50%, the polycarbonate is the continuous phase and the degradation of the CARILON is obscured or does not occur. Since we think that, for mechanical performance, a co-continuous structure is needed, the melt stability of an IPN of CARILON and polycarbonate is likely to be significantly improved over a system where polycarbonate is dispersed in the CARILON polymer.

The effect of the base polymer LVN on the rate of viscosity rise is shown in Figure 7A and B, the lower figure is the higher LVN base polymer. There is a substantially larger relative rise in the higher LVN base polymer. It is tempting to dismiss this as simply a faster (in time) effect on the base polymer because of the higher initial viscosity but it is not clear that this is the effect. This point will be discussed in a later general report on the viscosity of CARILON polymers now in preparation.

Ternary SERIES 2 blends are shown in Figure 8. The legend in this figure is now present in order of decreasing viscosity rise. The surprising finding is that those polymers which showed the highest interaction in the data of Figure 5, show the lowest viscosity rise in this figure. On inspection of the STEM micrographs, these blends looked as if they had a significant portion of co-continuous structure. The polymer compatibilizers appeared to effectively "template" or create the IPN structure which leads to the melt viscosity behavior that resembles polycarbonate rather than CARILON base polymer.

The effect of maleated polybutylene on the two different LVN CARILON base polymers is shown in Figure 9A and B, the higher LVN polymer is shown in the lower figure. While the effect of the polymer at low concentrations (1%) and in the low LVN polymer at higher concentrations (10%) is to increase the viscosity

rise (an undesirable effect), the addition of 10% maleated PB to the higher LVN polymer clearly reduces the viscosity rise and shows some indication of lubricating the polymer. This is in agreement with R. L. Danforth's finding in very high LVN polymers.

## CONCLUSIONS AND FORWARD WORK

1. The viscosity rise is indicative of polymer interactions in binary blends, miscible polymers increase rate of rise while melt stabilizers (usually immiscible) reduce the rate of rise. Zn-Surlyn and Primacor appear to be melt stabilizers.
2. The blends which increase the rate of rise appear to facilitate the formation of IPN's which have lower rate of rise than controls.
3. There is only a slight indication of polycarbonate miscibility with CARILON even though it is predicted by analog calorimetry.
4. The 15 and 30 mm twin-screw extruders appear to be equivalent in preparing blends with similar operating parameters.
5. Maleated polybutylene improves flow and rate of rise in high LVN CARILON polymers.
6. Effective impact modifiers appear to be the class of thermoplastic elastomers, vis: KRATON polymers, TPU's, HYTREL, and PEBAX. Good interfacial adhesion and correct particle morphology are essential to impact improvement.

The forward program in blends includes a similar series of binaries of CARILON EP and other amorphous polymers, PPO, ANY, ABS, polysulfone, and the ternaries with the same impact modifiers used in the polycarbonate work. The program also includes screening of other modifiers, and the development of the techniques of reproducibly making IPN's with polycarbonate.

Table 1. Commercial Blends Known in 1987

**2. CRYSTALLINE-AMORPHOUS BLENDS**

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NYLON	ABS	ELEMID	BORG-WARNER
NYLON	PPO	GTX	GE
PBT	PC	VALOX	GE
PBT	PC	XENOY	GE
PET	PC	XENOY	GE
PET	PC	MAKROBLEND	MOBAY
PBT	AM-NYLON	BEXLOY	DU-PONT

**4. RUBBER-TOUGHENED BLENDS**

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AM-NYLON	BEXLOY C	DU-PONT
IONOMER	BEXLOY W	DU-PONT
PBT	BEXLOY J	DU-PONT
PAC	DELFIN	DU-PONT
PBT	DURALLOY	CELLANESE
PAC	DURALLOY	CELLANESE
NYLON 6/6	RIM-PLAST	LNP
PET	RYNITE SST	DU-PONT
NYLON	ZYTEL-408	DU-PONT
NYLON	ZYTEL ST801	DU-PONT

**Table 2. Binary Blends of CARILON 087/002 and "Polymer X"**

**A. DESCRIPTION AND EXTRUSION CONDITION ON 30 mm TWIN-SCREW**

<u>Blend</u>	<u>Polymer Id.</u>	<u>Polymer Type</u>	<u>Melt T °C</u>	<u>Feed Rate</u>	<u>f(Torque) Amps</u>
CB1 A	PK 087-002	CARILON EP Polymer	270	1.6	11.5
CB3 A	KG-1652	S-EB-S	235	3.8	7.0
CB3 B	KG-1901X	Maleated S-EB-S	245	3.8	10.0
CB3 C	PEBAX	Polyamide-polyether TPE	245	3.6	12.0
CB3 D	HYTREL	Polyester-polyether TPE	245	3.6	9.5
CB3 E	PRIMACOR	Ethylene-co-acrylicacid	245	3.8	9.0
CB3 F	ESTANE 58881	Polyether TPU	248	4.0	11.0
CB3 G	ESTANE 58122	Polyester TPU	240	4.0	11.0
CB3 H	MITSUI QF500	Maleated PP	230	4.0	6.0
CB3 I	MAL-PB	Maleated PB	244	4.0	4.0
CB3 J	SURLYN 9520	Zn-SURLYN Ionomer	240	2.6	10.0

**B. PROPERTIES OF INJECTION MOLDED BLENDS**

<u>BLEND</u>	<u>POLYMER</u>	<u>INJ TIME sec</u>	<u>INJ PRESSURE psi</u>	<u>RT IZOD J/M</u>	<u>-20°C IZOD J/M</u>	<u>ZGL TENSILE PSI</u>	<u>ZGL ELONG %</u>
CB1 A	PK 087/002	5.0	600	94	47	8110	44
CB3 A	KG-1652	2.5	500	164	73	6100	37
CB3 B	KG-1901X	4.0	450	205	89	4400	37
CB3 C	PEBAX	2.4	400	135	52	5400	37
CB3 D	HYTREL	4.0	400	161	63	4900	35
CB3 E	PRIMACOR	4.0	500	133	66	5100	43
CB3 F	ESTANE 58881	4.0	500	169	56	3200	37
CB3 G	ESTANE 58122	4.0	500	254	92	6500	49
CB3 H	MITSUI QF400	4.0	250	106	57	5300	38
CB3 I	MAL-PB	4.0	250	136	57	4200	34
CB3 J	ZN-SURLYN	4.0	500	149	78	5200	53

**Table 3. Binary Blends of CARILON EP 087/002 With Polycarbonate**

**A. DESCRIPTION AND EXTRUSION CONDITION ON 30mm TWIN-SCREW**

<u>Series CB1 Based on PK-087/002</u>				
<u>Blend</u>	<u>Composition</u>	<u>Melt T °C</u>	<u>Feed Rate</u>	<u>f(Torque) Amps</u>
CB1 A	100% CARILON	270	1.6	11.5
CB1 B	20% PC M-40	270	1.6	10.5
CB1 C	40% PC M-40	270	1.6	11.5
CB1 D	60% PC M-40	270	1.5	9.5
CB1 E	80% PC M-40	270	1.5	13.0
CB1 F	100% PC M-40	270	1.5	15.5

<u>Series CB5 Based on PK-087/002</u>			
<u>30mm Haeke</u>		<u>15mm BP</u>	
<u>Blend</u>	<u>Composition</u>	<u>Blend</u>	<u>Composition</u>
CB5 A	10% PC M-40	CB5 F	10% PC M-40
CB5 B	15% PC M-40	CB5 G	15% PC M-40
CB1 E	20% PC M-40	CB5 H	
CB5 D	15% PC M-40	Based on PK-087/006	
CB5 E	20% PC M-40		

**B. PROPERTIES OF BLENDS INJECTION MOLDED CN ARBURG 2**

<u>BLEND</u>	<u>POLYMER</u>	<u>RT IZOD J/M</u>	<u>-20°C IZOD J/M</u>	<u>RT GARDNER JOULES</u>	<u>ZGL TENSILE PSI</u>	<u>ZGL ELONG %</u>	<u>DMTA MODULUS GPA</u>
CB1 A	100% CARILON	95	47	43	8110	44	2.37
CB1 B	20% PC M-40	28	26	45	5275	29	2.40
CB1 C	40% PC M-40	39	24	41	4250	38	2.62
CB1 D	60% PC M-40	160	74	45	4900	55	2.75
CB1 E	80% PC M-40	206	68	45	5420	33	2.84
CB1 F	100% PC M-40	725	183	45	9442	34	3.16
CB5 A	10% PC M-40	48	29				
CB5 B	15% PC M-40	39	25				
CB5 D	20% PC M-40	107	38				

Table 4. Ternary Blends of CARILON EP 087/002,  
Polycarbonate, and "Polymer X"

A. BLEND DESCRIPTION AND EXTRUSION CCNDITIONS ON 30mm TWIN-SCREW

<u>Blend</u>	<u>Polymer X</u>	<u>Melt T °C</u>	<u>Feed Rate</u>	<u>f(Torque) Amps</u>
CB2 A	KG-1652	250	3.8	6.0
CB2 B	KG-1901X	238	3.8	12.0
CB2 C	PEBAX	220	3.6	8.0
CB2 D	HYTREL	238	3.6	6.0
CB2 E	PRIMACOR	252	3.8	12.0
CB2 F	ESTANE 58881	220	4.0	10.0
CB2 G	ESTANE 58122	220	4.0	5.0
CB2 H	MITSUI QF500	238	4.0	10.0
CB2 I	MAL-PB	220	4.0	5.0
CB2 J	SURLYN 9520	240	2.6	10.0

B. IMPACT PROPERTIES OF INJECTION MOLDED BLENDS

<u>BLEND</u>	<u>POLYMER X</u>	<u>INJ TIME sec</u>	<u>INJ PRESSURE psi</u>	<u>RT IZOD J/M</u>	<u>-20°C IZOD J/M</u>
CB2 A	KG-1652	5.0	1000	66	40
CB2 B	KG-1901X	5.0	1300	45	34
CB2 C	PEBAX	5.0	450	43	48
CB2 D	HYTREL	5.0	600	82	35
CB2 E	PRIMACOR	5.0	450	61	47
CB2 F	ESTANE 58881	5.0	1000	76	51
CB2 G	ESTANE 58122	5.0	500	123	65
CB2 H	MITSUI QF400	5.0	500	83	47
CB2 I	MAL-PB	5.0	500	52	33
CB2 J	ZN-SURLYN	5.0	500	120	48

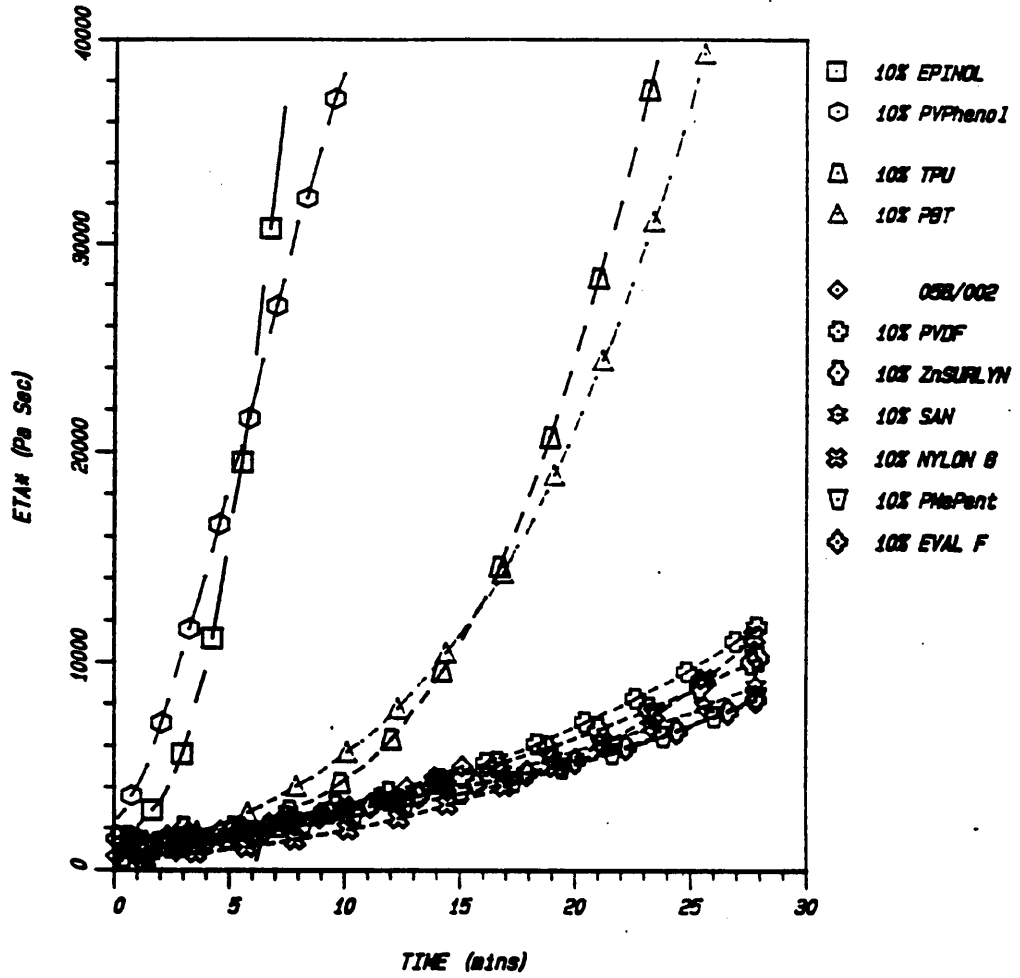


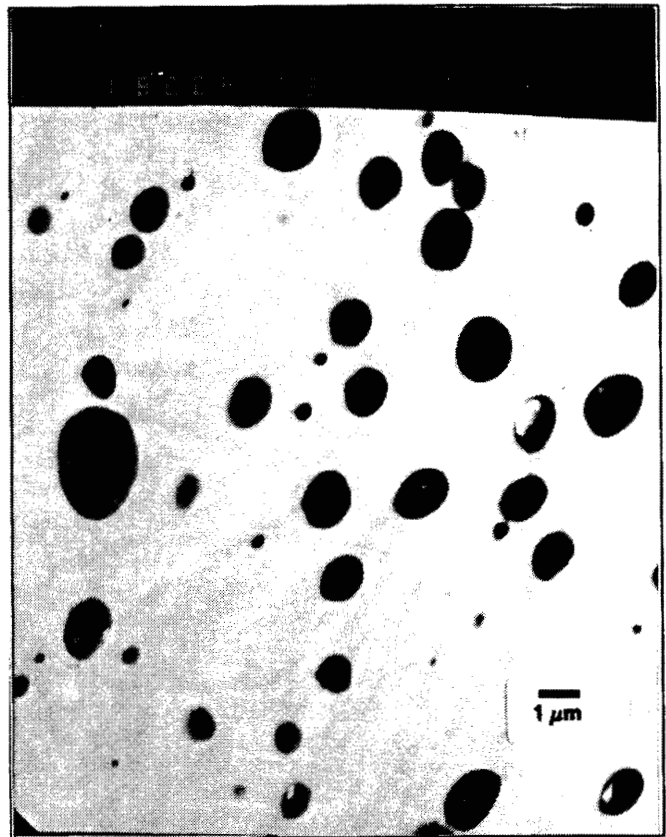
Figure 1. CARILON Polymer Blends  
Extruded 240°C on 15 mm, ETA \* at 275°C

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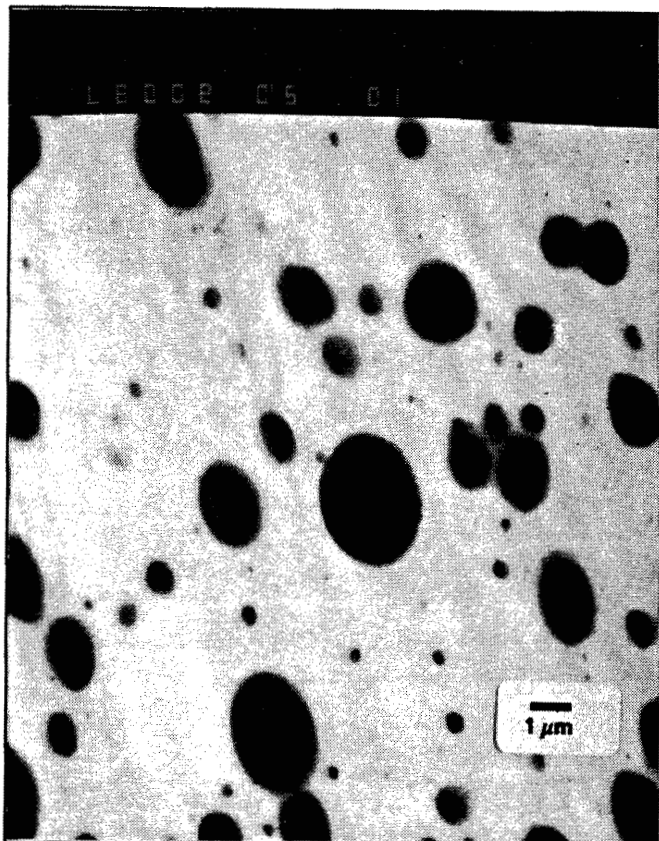




10% Primacor 1430, 87/002



10% Estane, 5888/PET, 87/002



10% TPU 58/22 FeS, 87/002

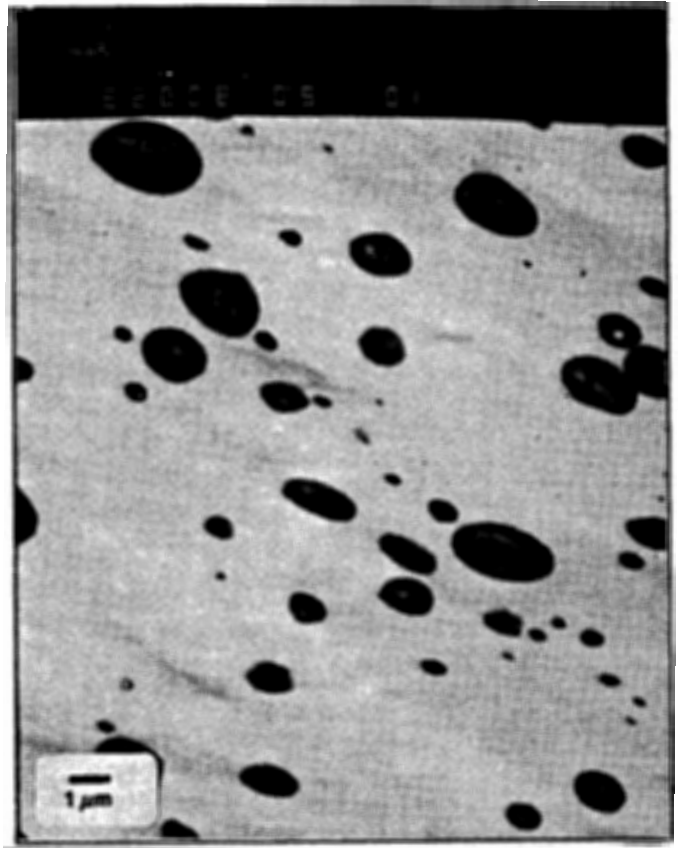


10% Mitsui, QF 500

Figure 2A.



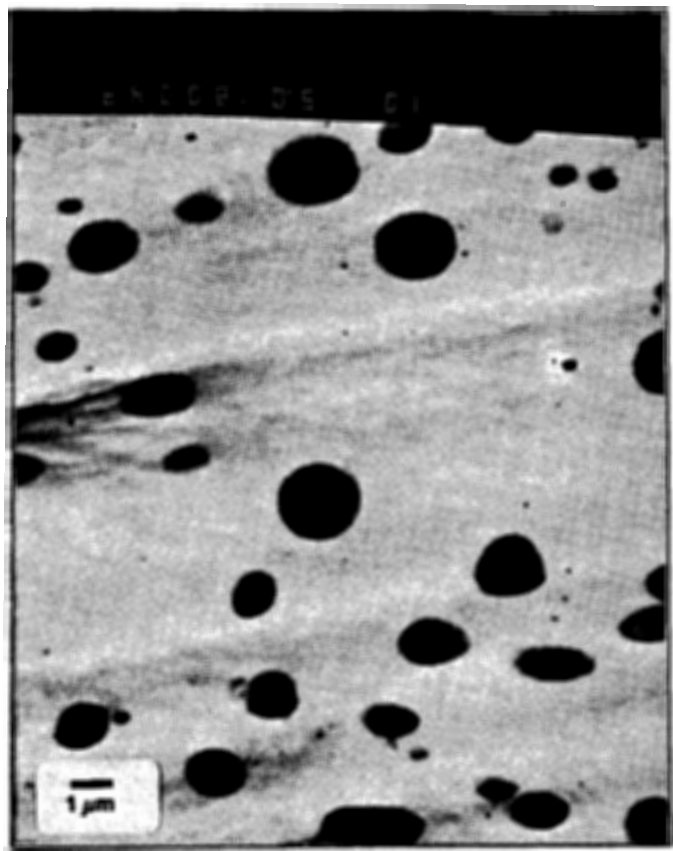
10% KG 1652, 87/002



10% KG 1901X in 87/002

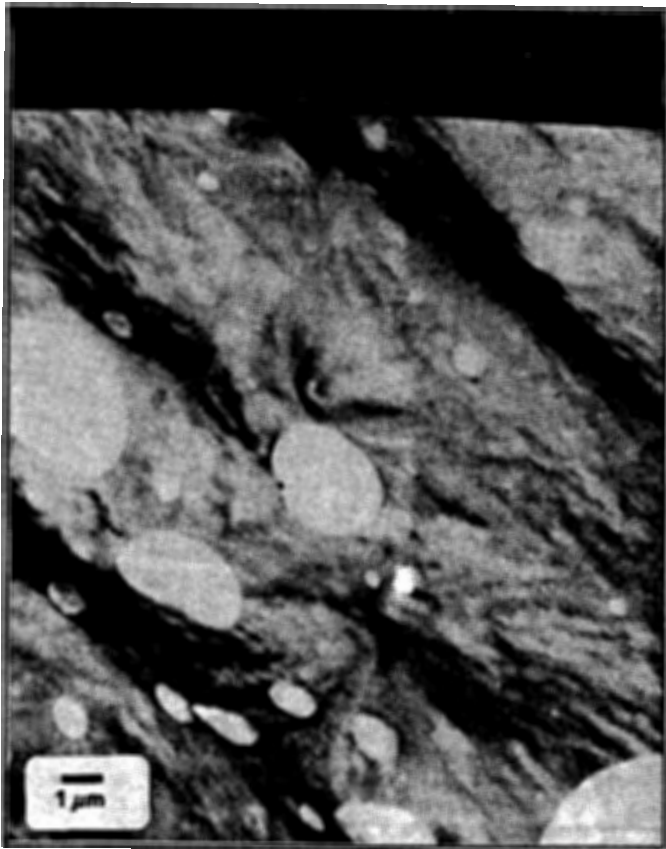


10% PEBA in 87/002

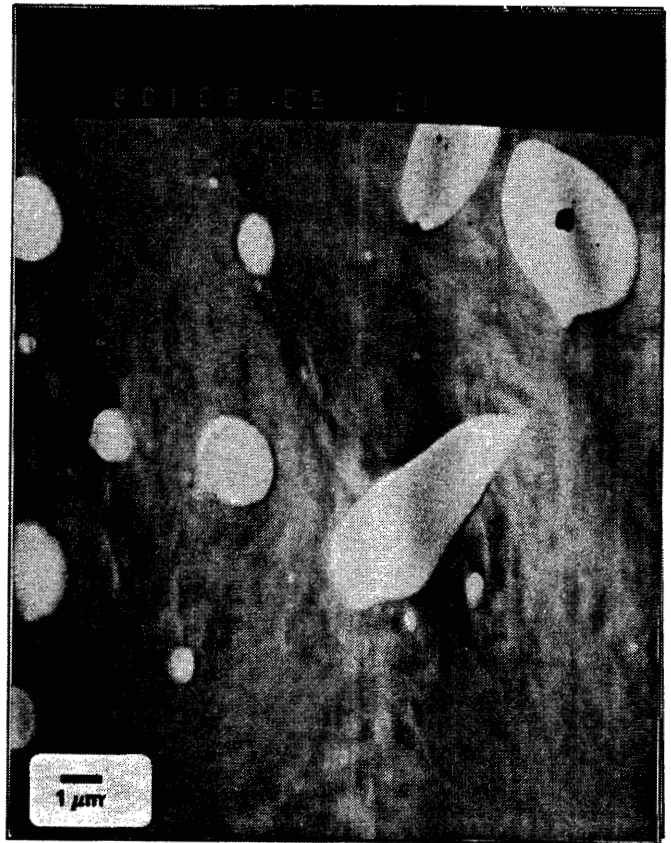


10% Hytel 4056

Figure 2B.

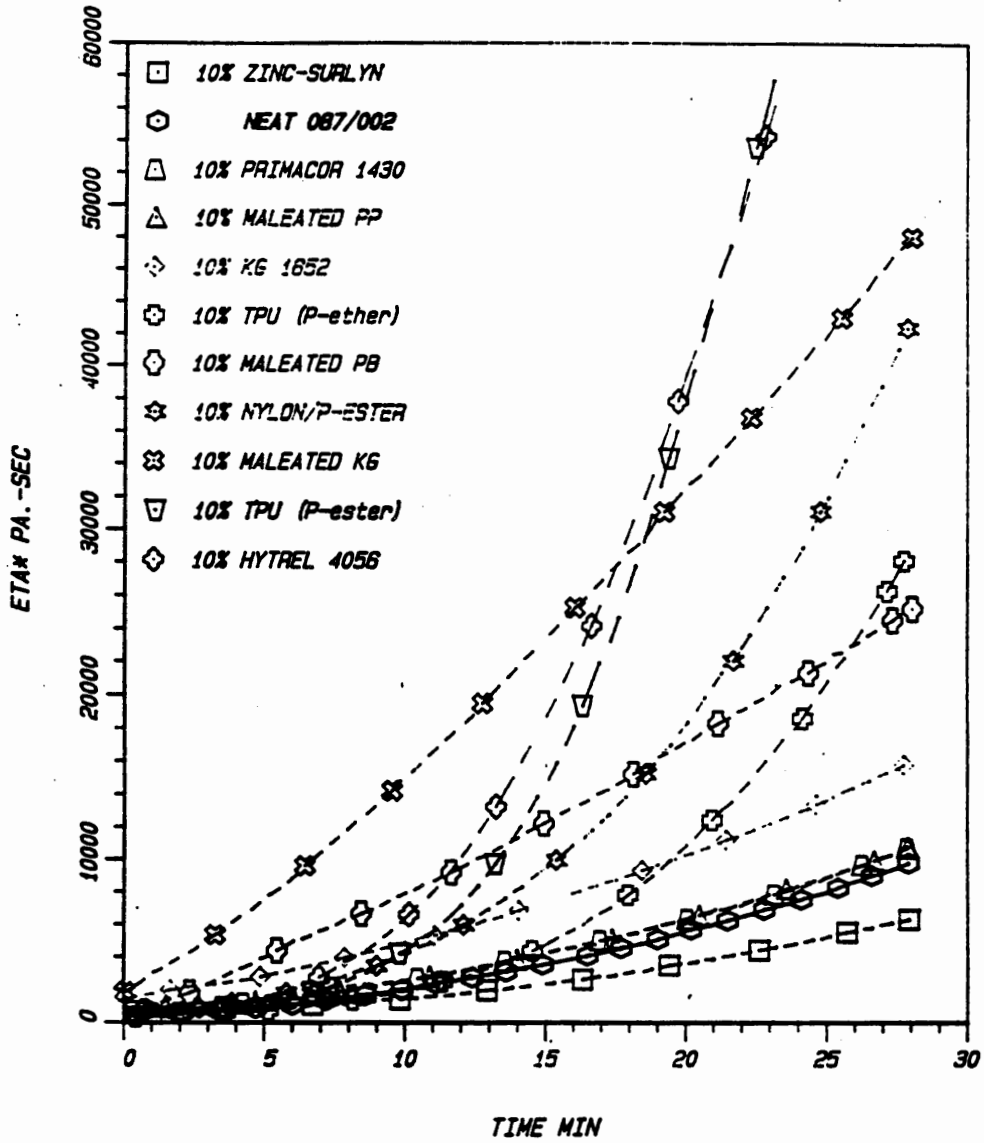


10% Maleated PB, 87/002



10% ZN Surlyn

Figure 2C.



**Figure 3. Blend Binary Series 3**  
PK 087/002 + Polycarbonate, 275°C

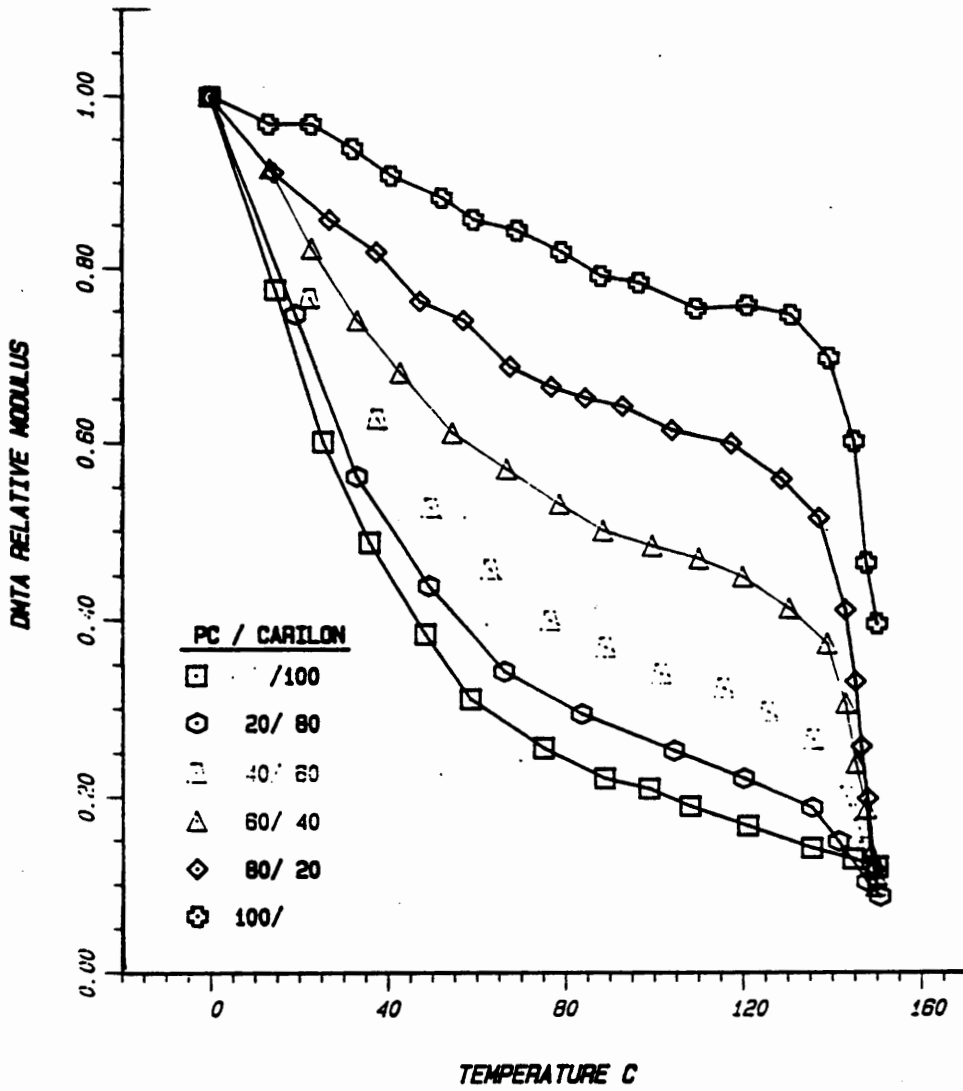


Figure 4. Polycarbonate CARILON Blend Series

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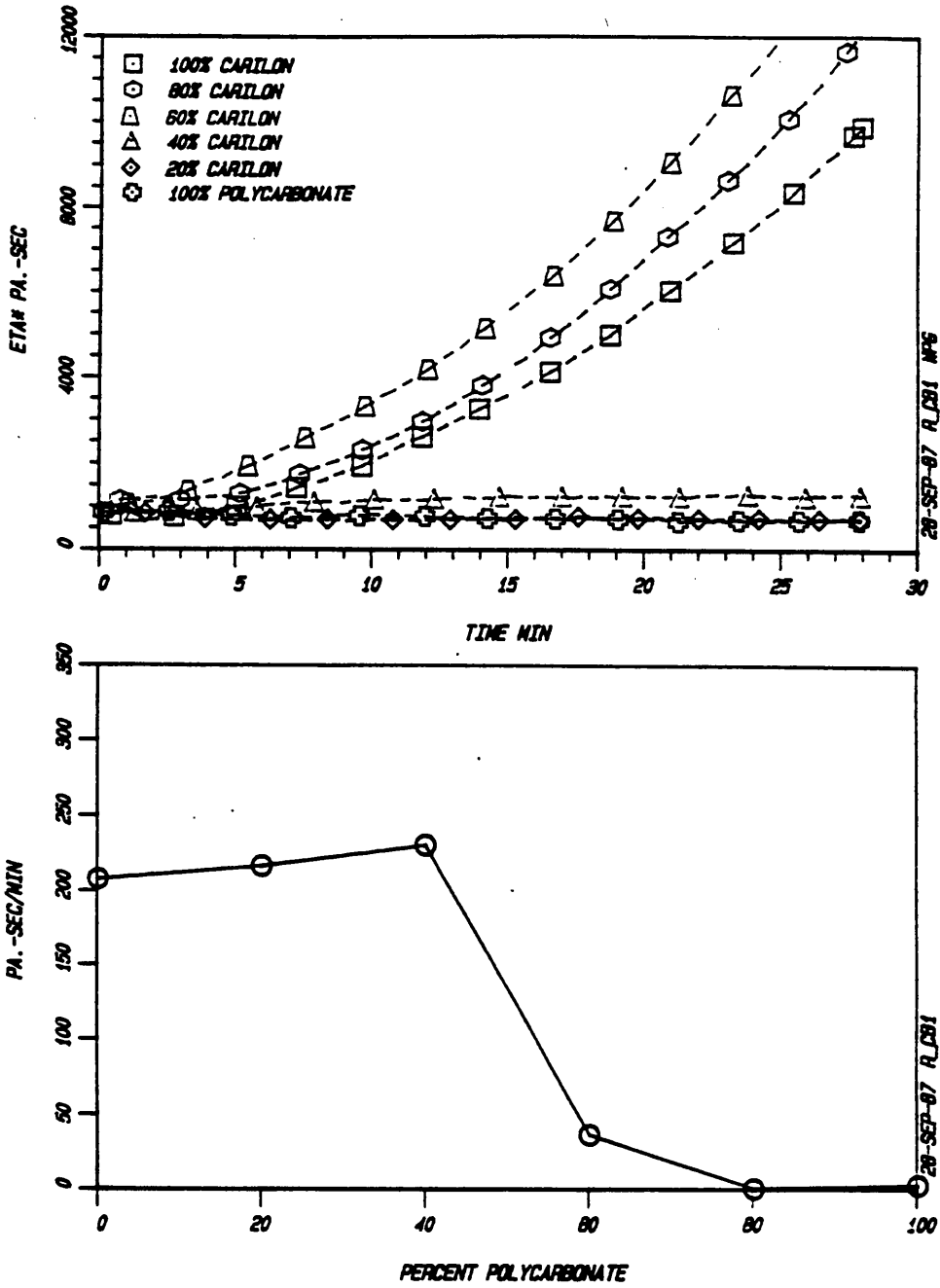
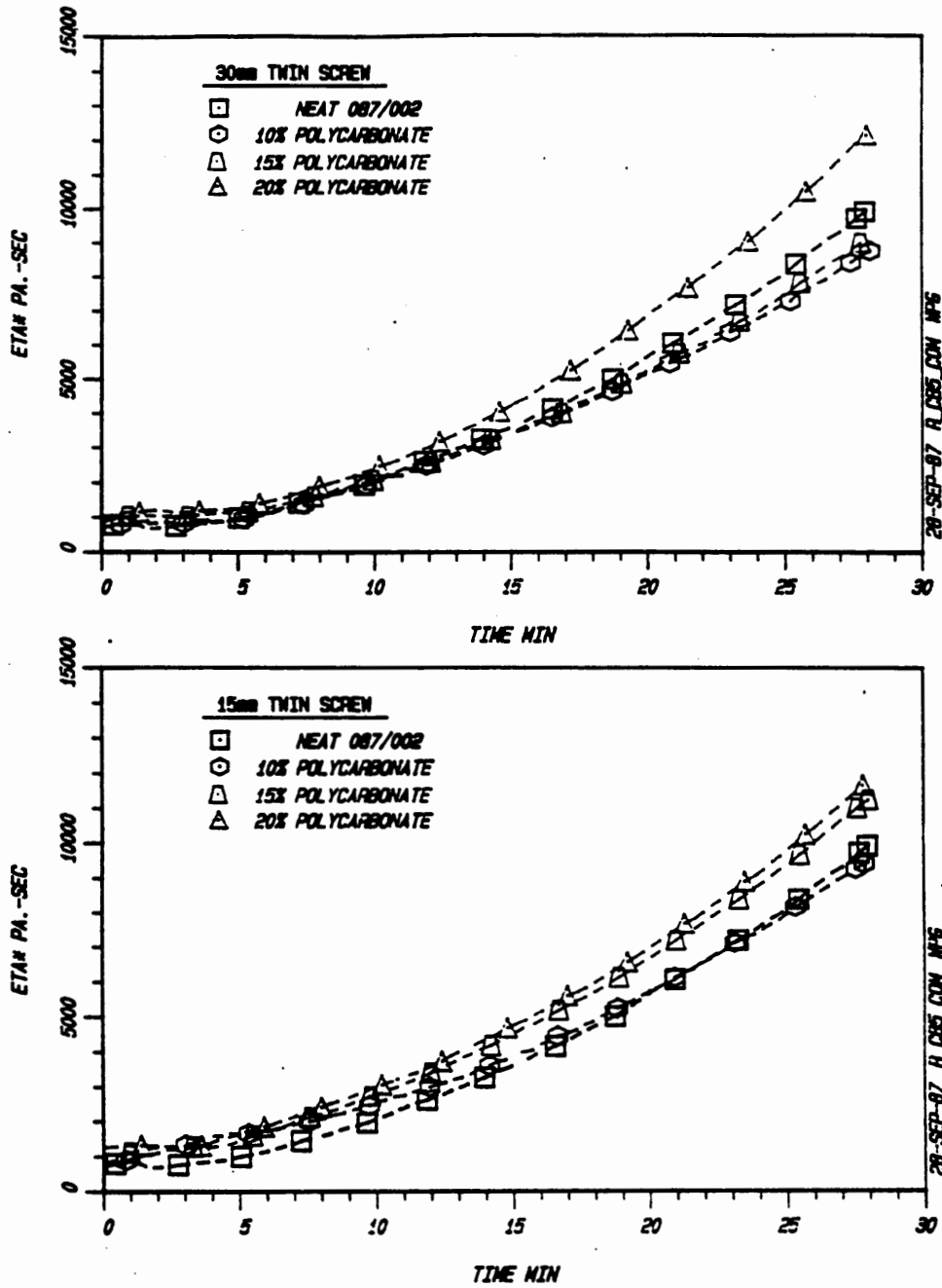
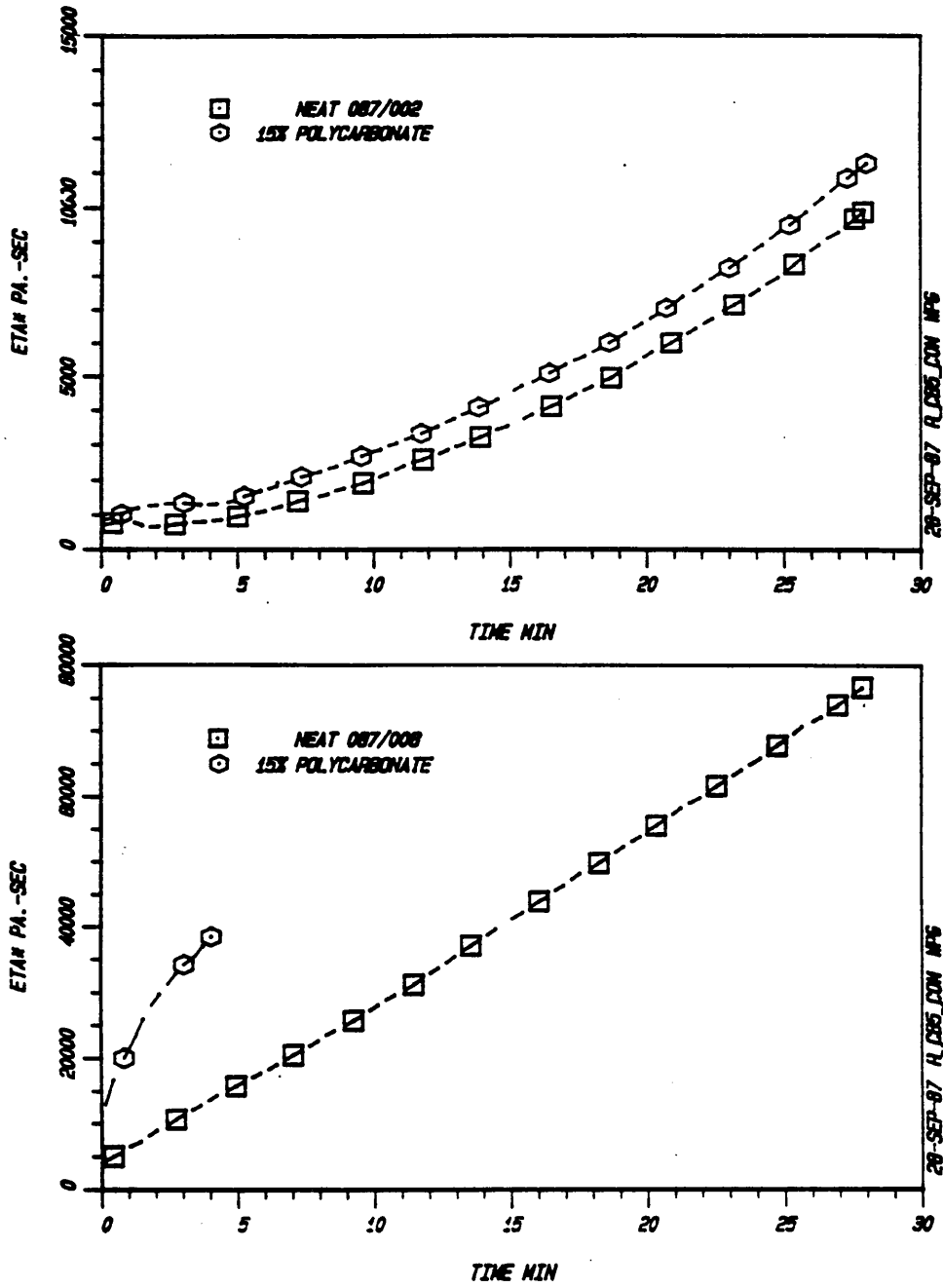


Figure 5. Blend Binary Series 1  
PK 087/002 + Polycarbonate

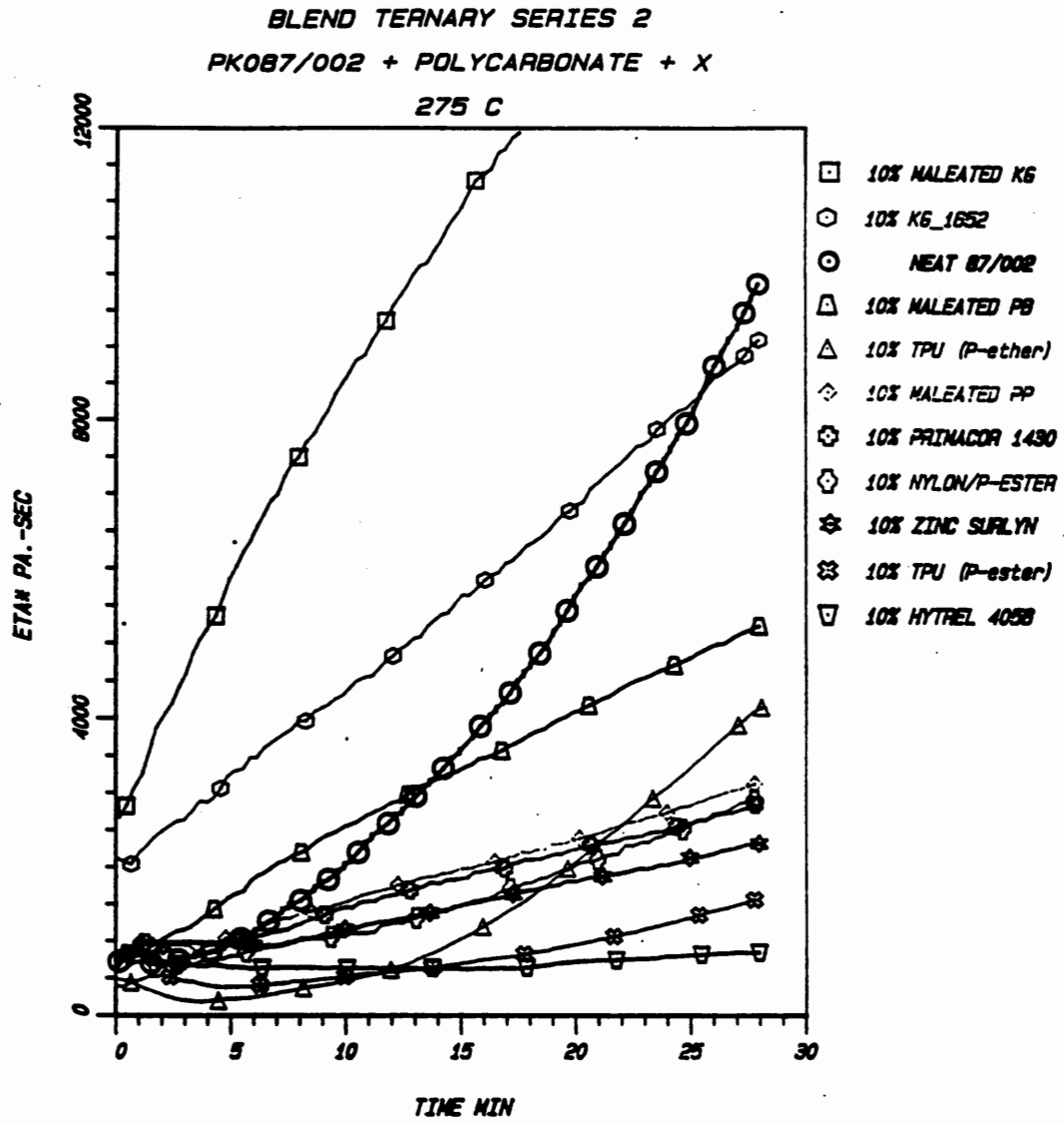


**Figure 6. Blend Binary Series 5**  
15 and 30 mm Twin-Screw Mixed 087/002 + PC



**Figure 7. Blend Binary Series 5  
Effect of Base Polymer on Slope**





**Figure 8. Blend Ternary Series 2**  
**PK 087/002 + Polycarbonate + X, 275°C**

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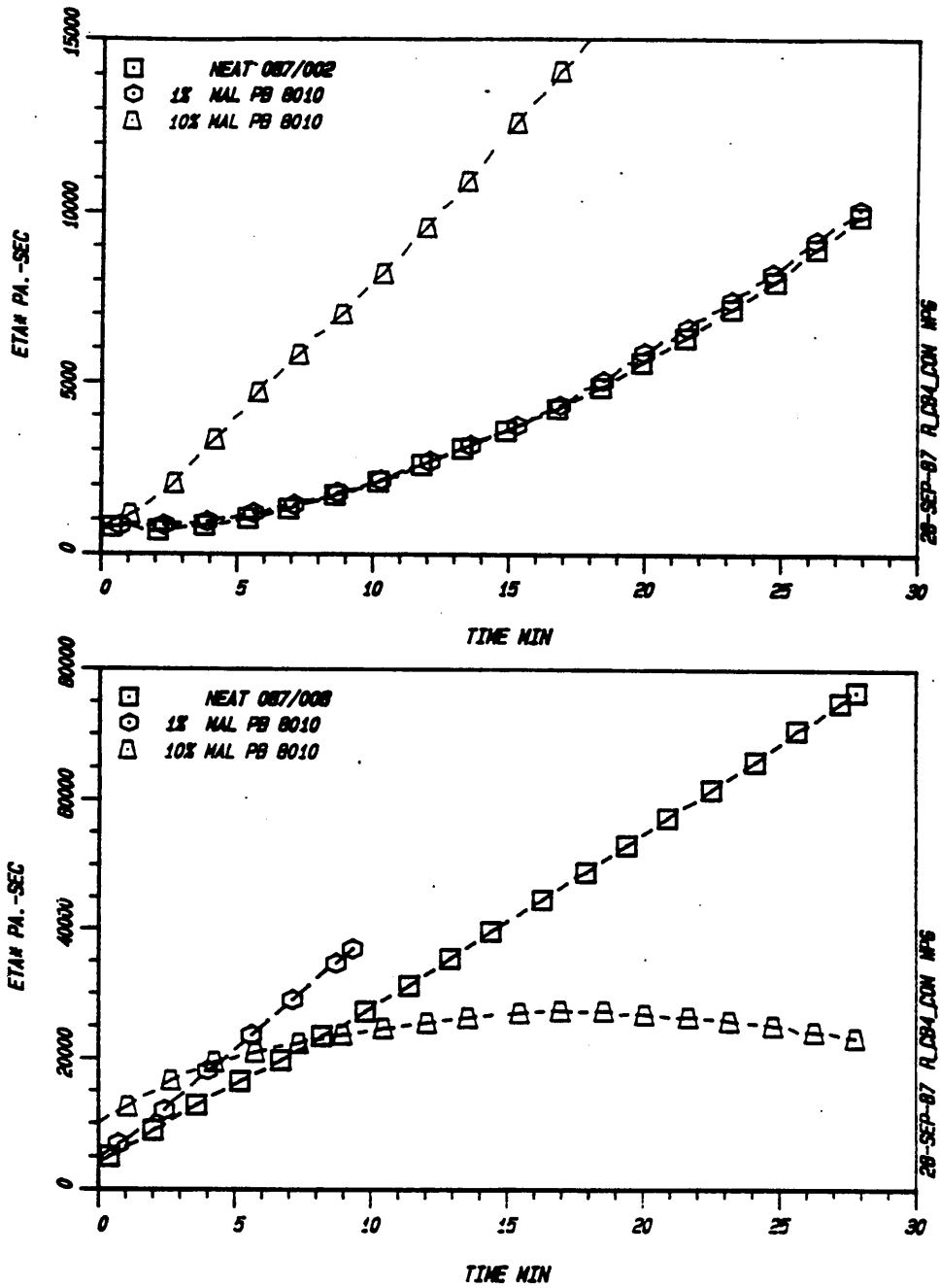


Figure 9. Blend Binary Series 4 =  
087/002, 087/006 + Maleated PB 8010

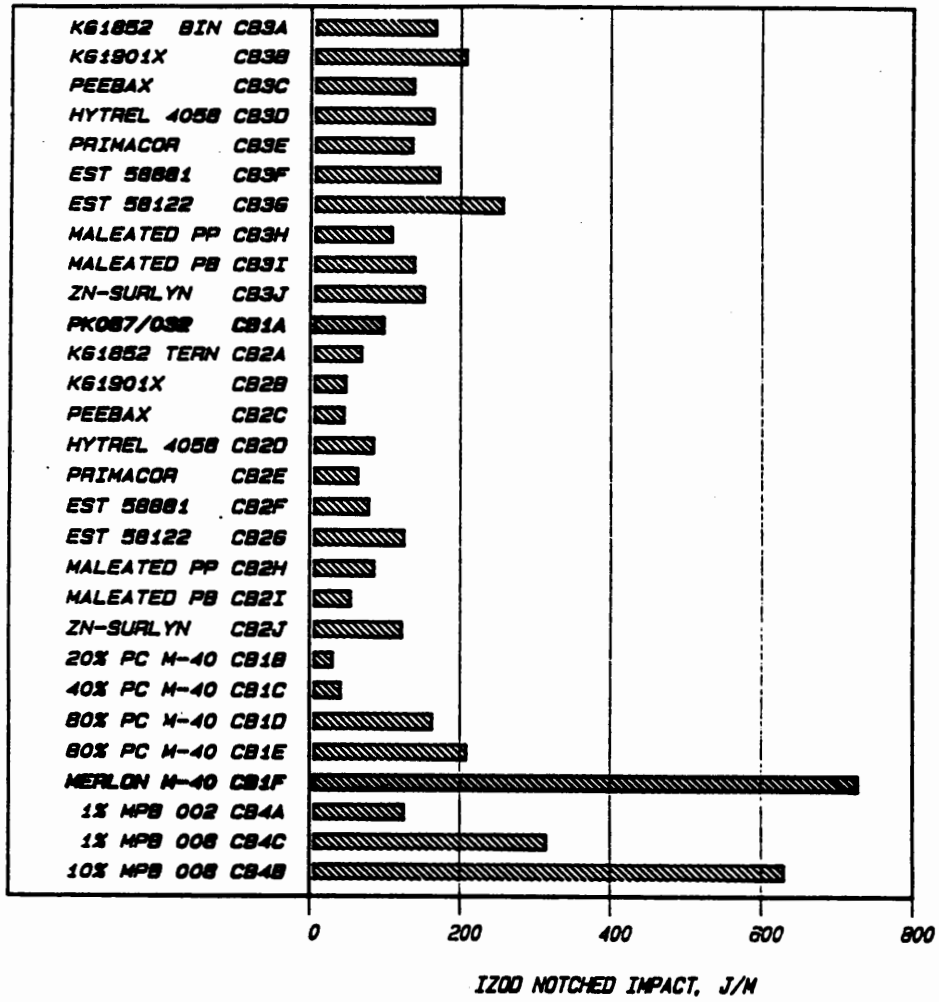


Figure 10. Comparative Impact of CARILON Blend Series Measured at Room Temperature on Injection-Molded Bars

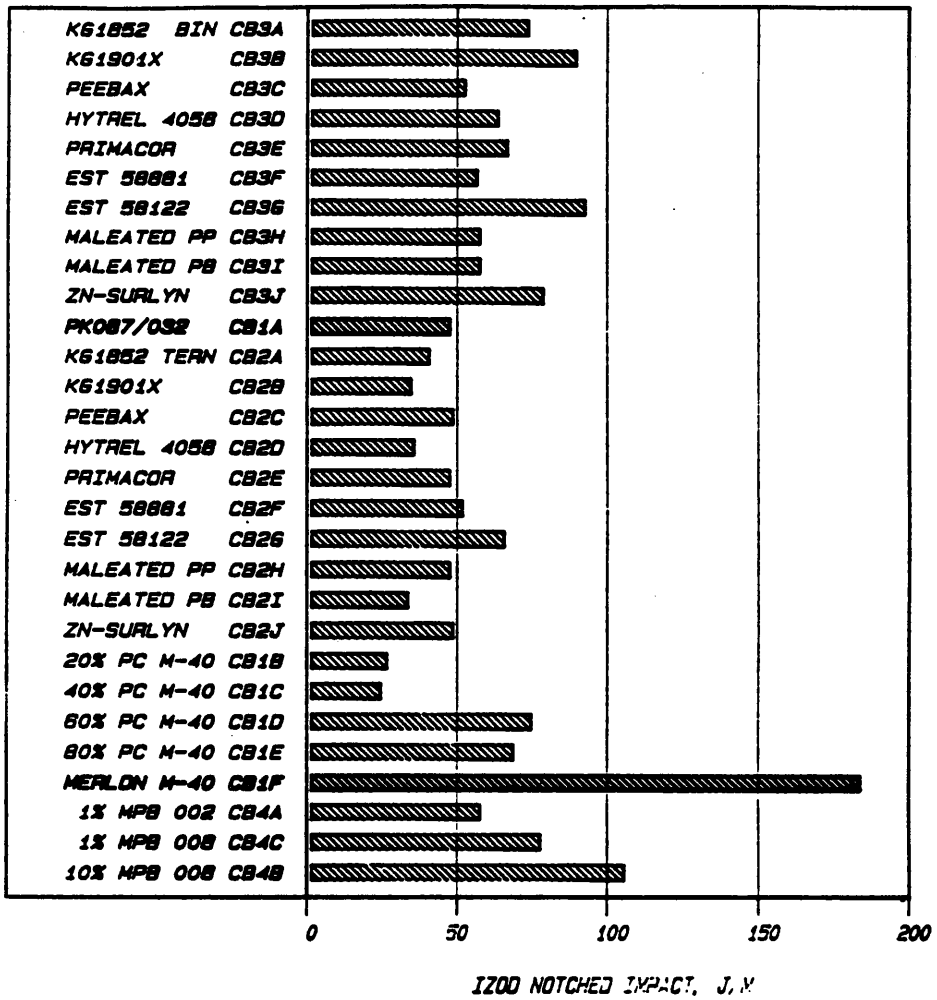


Figure 11. Comparative Impact of CARILON Blend Series Measured at -20°F on Injection-Molded Bars

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