

## ULtrasonic-aided Extrusion Process for Recycling of Rubbers and Copolymerization of Polymer Blends

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**ABSTRACT** : This paper describes recent advances in ultrasonic devulcanization technology and the in-situ ultrasonic compatibilization of the blends of the immiscible polymers by making copolymers at the interface and their vicinities and our understanding of the mechanism of these processes.

*Keywords* : ultrasonic devulcanization, rubber, recycling, extrusion

### I. Introduction

Recycling of rubber tires is an enormous environmental problem because of the great number of tires scrapped each year. According to a recent survey of the Scrap Tire Management Council, Rubber Manufacturers Association, approximately 270 million scrap tires are generated annually in the USA.<sup>1</sup> The markets for scrap tires are currently consuming about 66% of that total amount while the rest is added to an existing stockpile of an estimated 800 million scrap tires located around the USA. The major use of scrap tires in the U.S. is generating a so-called tire-derived fuel. About 64% of the consumed scrap tires have been burnt in 1998, and only 13% of the total consumed amount have been turned into ground tire rubber (GRT) which is the initial material for the tire rubber recycling processes.<sup>1</sup> Waste tires, being made of high quality rubbers, represent a large potential source of raw material for the rubber industry. Other waste rubbers have become a growing problem in rubber industry. It is estimated that over 150,000 tons of rubber are scrapped from the production of non-tyre goods in

forms of runners, trim and pads.<sup>2</sup>

The application of ultrasonic waves to the process of rubber devulcanization is the most recent approach. Ultrasonic devulcanization discovered in our laboratory is now considered as one of the most promising rubber recycling methods.<sup>3</sup> The experiments using ultrasound<sup>4-12</sup> have been conducted on various types of reinforced and non-reinforced rubbers. The ultrasonically treated rubber becomes millable and moldable; therefore, the material can be reprocessed, shaped and revulcanized in a manner similar to that employed with unvulcanized elastomers.

Polymer blending is a useful approach for the preparation of new materials with specially tailored or improved properties that are often absent in the single component polymers. However, many polymer pairs are incompatible or immiscible with each other and exhibit either very low or no interfacial adhesion and phase separate on blending. In most cases, melt mixing of two dissimilar polymers results in blends that are weak and brittle. Therefore, compatibilization of the polymer blend is required.<sup>13-16</sup> Compatibilization is achieved by the addition of a third component, typically a block copolymer, to the system, or by inducing a chemical

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reaction using chemicals, leading to modification of the polymer interfaces in two-phase blends, and thereby to tailoring of the phase structure, and hence properties. Block copolymers contain blocks chemically identical to the blend component polymers assuring miscibility between the copolymer segments and the corresponding blend component. However, these methods are likely to be restricted to the use of available polymers and the synthesis of block copolymers is not available for most polymer pairs of interest. It was recently discovered in our laboratory that the ultrasonic treatment of polymer blends in molten state can introduce *in-situ* chemical reaction at the interface nanolayer leading to compatibilization and mechanical property enhancement of the blends.<sup>17</sup>

This paper describes recent advances in ultrasonic devulcanization technology and the *in-situ* ultrasonic compatibilization of the blends of the immiscible polymers by making copolymers at the interfaces and their vicinities and our understanding of the mechanism of these processes.

## II. Materials and Methods of Investigation

Extensive devulcanization experiments were performed on ground tire rubber (GRT), SBR, NR, SBR/NR blends, PDMS and EPDM vulcanizates. PDMS rubber was cured using dicumyl peroxide. This rubber was studied with and without inclusion of precipitated and fumed silica. Other unfilled and carbon black filled rubbers were cured by means of sulfur curative recipe. Curing, structural, rheological and mechanical properties are studied. Comparison of curing behavior of virgin and devulcanized rubbers was carried out using Monsanto Curemeter and Advanced Polymer Analyzer (APA2000, Flexsys). Structural properties studied included the crosslink density measured by means of swelling, gel fraction measured by means of the Soxhlet extraction. Also, NMR studies were carried out. Rheological properties included steady-state

viscosity as a function of shear rate using Monsanto Processibility Tester (MPT) and dynamic properties (the storage and loss moduli, complex dynamic viscosity and tan $\delta$  using APA2000) as a function of the frequency. The stress-strain behavior was measured by means of Monsanto Tensiometer.

Ultrasonic treatment of polyolefin/rubber and rubber/rubber blends were also carried out. Polyolefins (HDPE or PP) and uncured rubbers (NR, SBR or EPDM) were first mixed using a twin screw extruder (JSW Labotex30) before ultrasonic treatment. The composition of each of these polymer blends was 50:50 by wt. The feed rate was 60 g/min. Screw speed was set at 150 rpm and zone temperatures of 140°C/140°C/145°C/150°C/150°C/155°C/160°C/160°C for HDPE/rubber blends and 165°C/165°C/175°C/180°C/180°C/185°C/190°C/190°C for PP/rubber blends were used. After the mixtures were extruded from the twin screw extruder, the extrudates were cooled, pelletized and then dried in a vacuum oven for 24 hours at a temperature of 60°C.

### 1. Ultrasonic reactors

Several ultrasonic reactors developed in our laboratory are shown in Figure 1. A coaxial reactor (Figure 1a), a barrel reactor (Figure 1b) and a barrel reactor with helical channels (Figure 1d) are based on a 38.1 mm single screw rubber extruder. In the coaxial reactor, an ultrasonic die attachment contains one horn with axis of longitudinal oscillations being parallel to the axis of the screw. In the barrel reactor, two ultrasonic horns are installed in the barrel of the extruder. In the barrel reactor with helical channels, two helical channels are made in the internal barrel surface and two horns located in these channels. In both barrel reactors, the longitudinal oscillations of horns are in the direction perpendicular to the screw axis.

Also, in all the reactors the material passes through a narrow gap. In the case of the coaxial reactor the gap is created between the face of the horn and exit surface of the extruder. In the case of the barrel reactors, the gap is created between

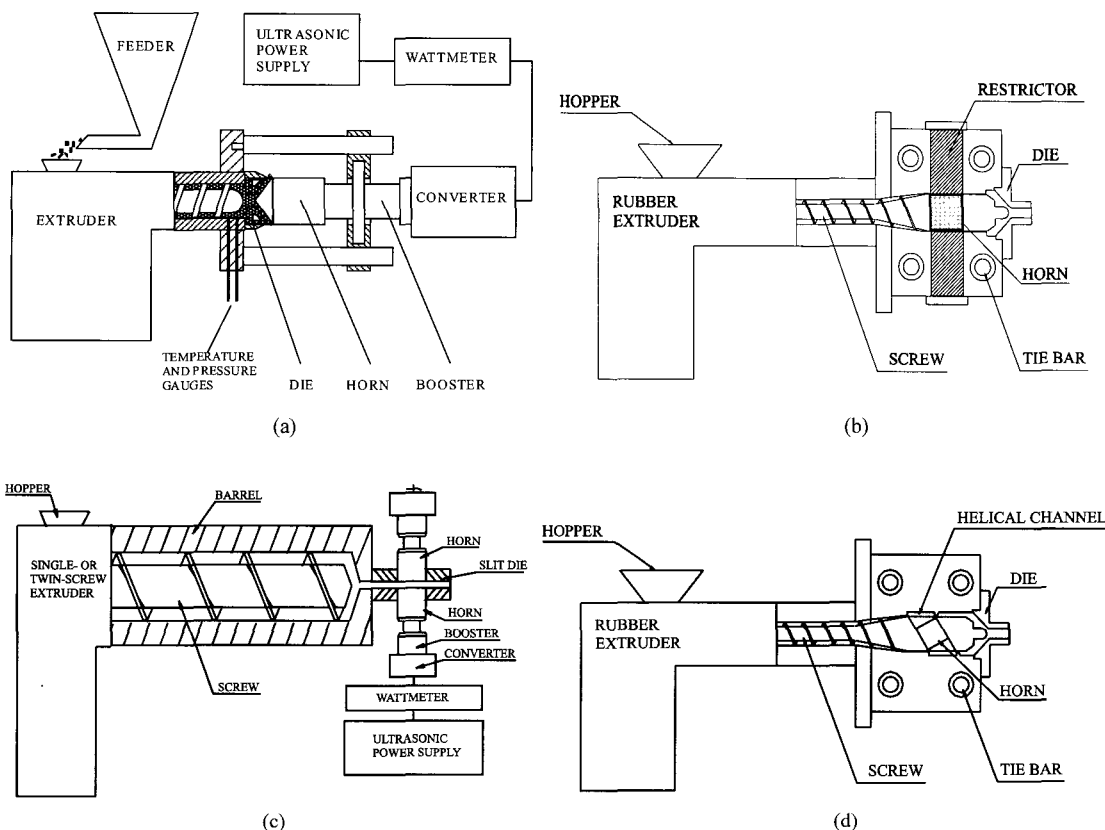


Figure 1. Various ultrasonic extrusion reactors built in our laboratory.

the face of the horns and a rotating screw surface. The reactor depicted in Figure 1c is based on a 25.4 mm plastic extruder with a slit die where two horns are inserted into the die. The horns can operate independently such that one or both horns can be activated. In all the reactors oscillations are being directed perpendicular to the flow direction of the material. The frequency of oscillations was 20 kHz. Amplitudes are varied from 5 to 10  $\mu\text{m}$ .

### III. Results and Discussions

#### 1. Devulcanization Studies

Figure 2 shows the entrance pressure of devulcanization zone vs. amplitude of ultrasound at a flow rate of 0.63 g/s, and vs. flow rate at an amplitude

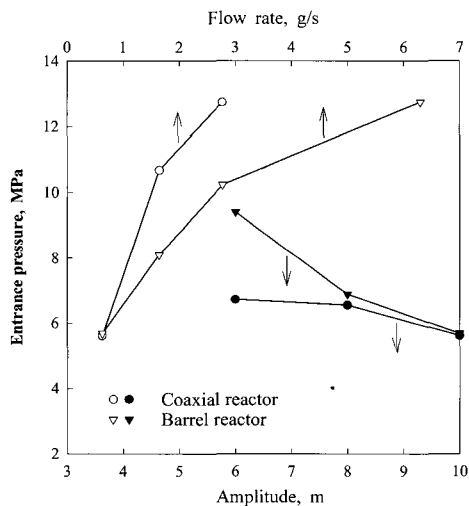


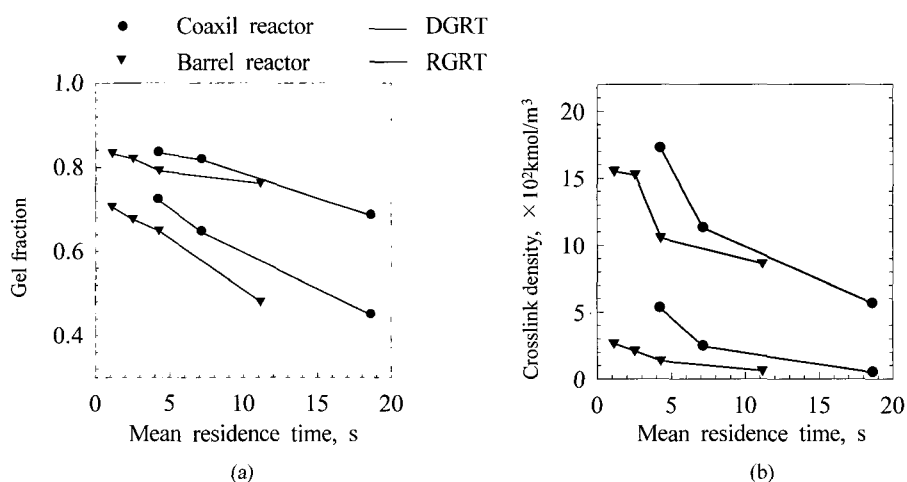
Figure 2. Entrance pressure of devulcanization zone vs. ultrasonic amplitude at flow rate of 0.63 g/s (solid symbols) and vs. flow rate at an amplitude of 10  $\mu\text{m}$  (open symbols).

of 10  $\mu\text{m}$ . The entrance pressure is substantially reduced as the amplitude of ultrasound is increased. Ultrasound facilitates the flow of rubber through the gap not only because of reduction of the friction in the presence of ultrasonic waves but also because of the devulcanization taking place as GRT particles enter the devulcanization zone. The barrel reactor shows a higher pressure in the devulcanization zone than the coaxial reactor at low amplitude of ultrasound and a flow rate of 0.63 g/s. The barrel reactor has a converging zone before the devulcanization zone. The GRT flow is essentially blocked by the restrictor of the devulcanization zone at a low amplitude of ultrasound. However, at an ultrasound amplitude of 10  $\mu\text{m}$ , the entrance pressure of the devulcanization zone for the two reactors is almost the same due to a reduction of restrictor effect at high amplitude. The devulcanized sample of flow rate of 6.3 g/s for the coaxial reactor could not be obtained due to an overload of the ultrasonic generator. It is natural that the entrance pressure of devulcanization zone rises with increasing flow rate as indicated in Figure 2 for both the reactors. Nevertheless, at high flow rate the barrel reactor has a lower entrance pressure at the devulcanization

zone than that of the coaxial reactor at an ultrasound amplitude of 10  $\mu\text{m}$ . The difference in die characteristics between the barrel and coaxial reactors, both having the thickness of devulcanization zone of 2 mm, is possibly related to the difference in power consumption and the difference in shearing conditions. In the barrel reactor, the GRT in the devulcanization zone is subjected to a pressure and drag flow while in the coaxial reactor to a pressure flow alone.

Figure 3 shows the gel fraction (a) and crosslink density (b) vs. the residence time for DGRT and RGRT using two reactors. Here, one can observe that an increase in the mean residence time leads to a lower gel fraction and crosslink density, i.e. a higher degree of devulcanization in both reactors. However, the barrel reactor leads to a higher degree of devulcanization at the same residence time.

Figures 4 and 5 show the distribution of gel fraction and crosslink density of samples obtained from various locations in the devulcanization zone of the coaxial and barrel reactor, respectively. It is seen that gel fraction and crosslink density decrease along the flow direction in both reactors. The samples taken at the exit of the devulcanization zone



**Figure 3.** Gel fraction (a) and crosslink density (b) vs. mean residence time in devulcanization zone for the DGRT (solid symbols) and RGRT (open symbols) prepared by the coaxial and barrel reactor at an amplitude of 10  $\mu\text{m}$ .

of the coaxial reactor have uniform gel fraction and crosslink density. In contrast the sample taken from the barrel reactor exhibits non-uniform gel fraction and crosslink density. This is caused by the significant non-uniformity of the residence time that the exiting rubber particles experience in the devulcanization zone in this reactor. Furthermore, the shearing and pressure non-uniformity due to screw rotation can also affect the degree of devulcanization

and the distribution of gel fraction and crosslink density in the devulcanization zone.

Crosslink density and gel fraction for ultrasonically devulcanized rubber can be correlated by a universal master curve (Figure 6). This curve is unique for each elastomer due to its unique chemical structure. Figure 6 presents the normalized gel fraction as a function of normalized crosslink density of DGRT obtained from two different reactors (a)

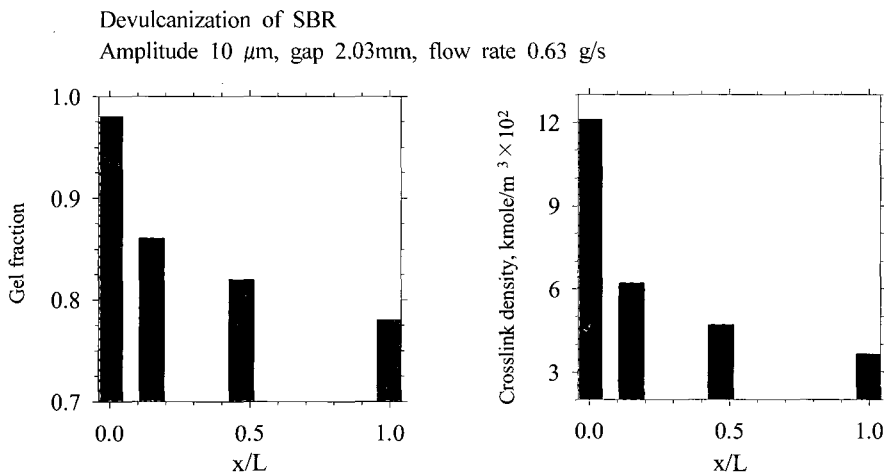


Figure 4. Distribution of the gel fraction (a) and crosslink density (b) in devulcanization zone of the co-axial reactor.

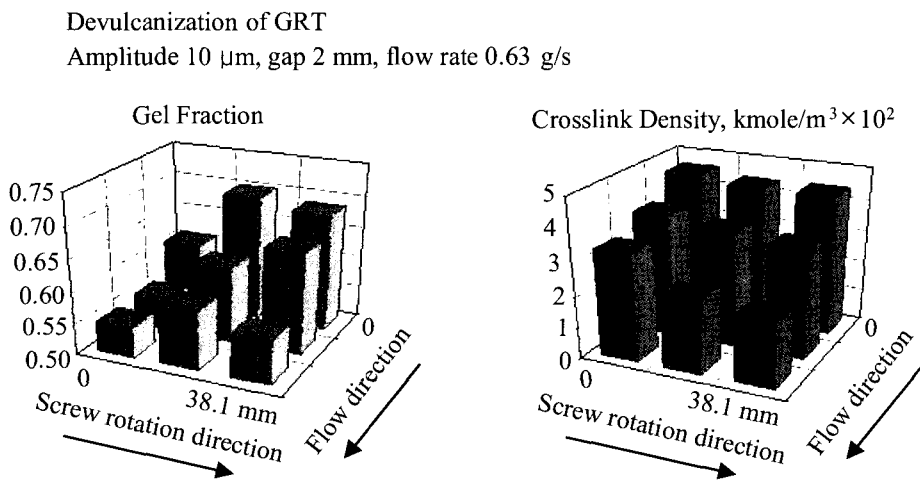
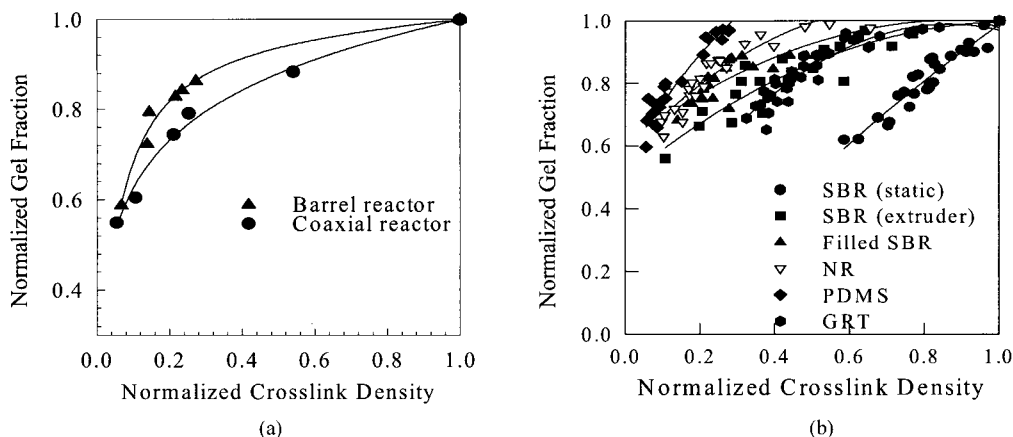


Figure 5. Distribution of gel fraction and crosslink density in devulcanization zone of the barrel reactor.

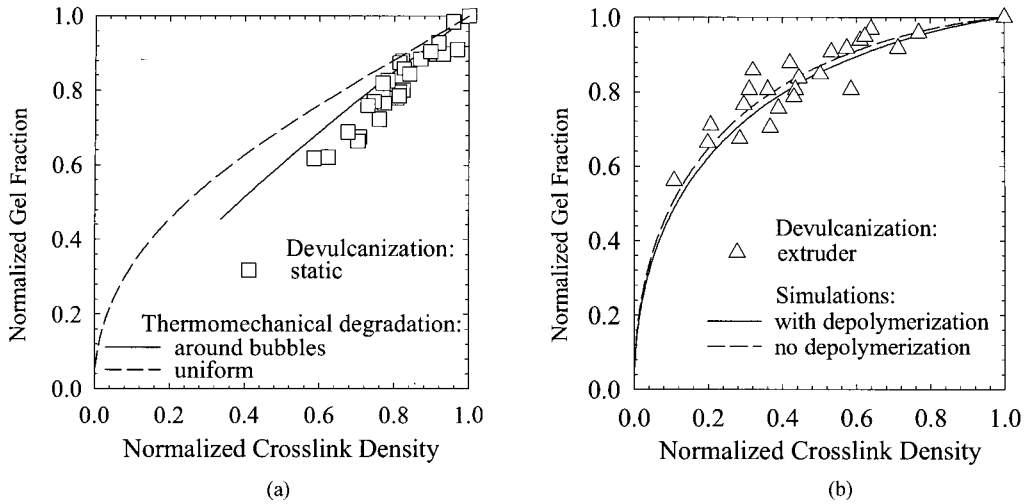


**Figure 6.** Normalized gel fraction vs. normalized crosslink density for devulcanized GRT obtained by the barrel and co-axial reactors and various devulcanized rubbers obtained in the co-axial reactor and static device.

and coaxial reactor for various devulcanized rubbers (b). For each reactor, the dependence of gel fraction on crosslink density is described by a unique master curve that is independent of processing condition such as flow rate (residence time) and amplitude. The unique correlation between gel fraction and crosslink density obtained in the barrel reactor is shifted toward lower crosslink density than those obtained in the coaxial reactor. Possibly, it is considered that additional shearing effect caused by the screw rotation in the barrel reactor had a positive influence on improving the efficiency of devulcanization.

The simulations of the ultrasonic power consumption and the temperature build-up in thin rubber layers suggested that thermal degradation of the rubber network might take place simultaneously with network rupture due to cavitation.<sup>18-20</sup> Thermal degradation of a cured rubber was modeled based on the random scission and on the depolymerization (unzipping) mechanisms, which are combined with the Dobson and Gordon theory of rubber network statistics.<sup>20</sup> It was assumed that depolymerization of a chain is initiated by the appearance of a radical pair caused by a primary random scission of the chain, and that the rate of depolymerization is greater than that of the random chain scission. The

model has been demonstrated to be capable of describing the experimental data on the structure of devulcanized SBR obtained under both static and continuous conditions.<sup>21</sup> The experimentally observed formation of visible cavities (bubbles) in SBR samples under static ultrasonic treatment<sup>21</sup> supported an assumption that the primary chain scissions take place around those bubbles in the course of their ultrasonic cavitation. As is shown in Figure 7a, this assumption allowed the achievement of a fairly good agreement between the experimental data of the dependency of gel fraction on crosslink density and the results of modeling. Simulations of spatially uniform thermomechanical degradation at the same value of the unzipping length could not provide such an agreement alone (Figure 7a). In contrast, the experimental data on devulcanization of SBR in the extruder (continuous conditions) can be successfully simulated if the random chain scissions are considered to proceed uniformly over a sample (Figure 7b). It is also seen in Figure 7b that the contribution of depolymerization to the degradation of the rubber network is not significant during the continuous ultrasonic treatment in the extruder die attachment. The remarkable difference between the values of unzipping length for the static and continuous devulcanization processes (300 in Figure 7a and 10 in



**Figure 7.** Simulation of the structural characteristics of SBR devulcanized in the static device (a) and coaxial reactor (b). (a) Random scissions with a subsequent unzipping are considered taking place around bubble (solid line) or uniformly over a sample (dashed line). Volume fraction of bubbles,  $\phi = 10^{-2}$  unzipping length  $l_z = 500$ . (b) Random chain scissions are considered as spatially uniform either with a subsequent chain depolymerization (solid line) or without it (dashed line). Depolymerization is characterized by the unzipping length  $l_z = 10$ .

Figure 7b) reflects a greater temperature buildup during devulcanization under static conditions.

The viscosity of devulcanized GRT decreases as the amplitude of ultrasound increases. As the amplitude is increased, the three-dimensional network in the GRT is easily broken down, making the rubber flowable. The samples from the coaxial reactor at same conditions, especially, at an amplitude of 8  $\mu\text{m}$ , exhibits much lower viscosity than that of the barrel reactor. This observation is in agreement with the lower gel fraction and crosslink density of the samples from the coaxial reactor (see Figure 6). The viscosity of GRT obtained at a high flow rate is higher. It is related to the mean residence time of GRT in the ultrasound zone. The increase in the flow rate leads to a decrease in the mean residence time in the devulcanization zone where the action of the ultrasonic waves takes place. Thus, the devulcanized samples, having a longer mean residence time, exhibit lower viscosity. At high flow rates, DGRT obtained from the coaxial reactor has a higher viscosity than DGRT obtained from the barrel reactor. This is another indication that the

coaxial reactor provides less devulcanization than the barrel reactor at high flow rates. Furthermore, even though the power consumption density of the barrel reactor is always higher than that of the coaxial reactor, the degree of devulcanization would depend on the processing conditions (e.g. the mean residence time and pressure of devulcanization).

The cure curves of DGRT indicate that the torque attains a minimum, then a maximum and subsequently decreases slightly. As the ultrasound amplitude increases, the maximum torque decreases. Generally, the higher the degree of devulcanization, the lower is the minimum torque as well as the maximum torque. Thus, cure curves are also an indirect indication of the degree of devulcanization. The barrel reactor gives less devulcanized sample than the coaxial reactor. The trend in variation of maximum and minimum torque is similar to that of crosslink density. The higher is the crosslink density of DGRT, the higher the maximum and minimum torque.

Processing parameters during devulcanization strongly affect the mechanical properties of reul-

canized rubber. As amplitude of the ultrasound increases, the tensile properties (ultimate tensile stress, modulus and elongation) decrease. This can be explained by the degree of devulcanization. An increase in amplitude at low flow rate may lead to the over-treatment of the sample. Thus, good tensile properties could not be achieved due to degradation of main chains of rubber. It is suggested that the high amplitude leads to a break down of the cross-links of rubber along with significant break up of main chains. At constant amplitude, the tensile strength, modulus and elongation at break of RGRT increase as the flow rate increases. Also, tensile modulus is in good agreement with the maximum torque on the cure curves. This observation is in an agreement with literature<sup>22</sup> indicating a direct correlation between the tensile modulus and the maximum torque. In addition, it is interesting to note that RGRT, prepared from DGRT having a higher gel content corresponding to a higher flow rate, shows better mechanical properties. In other words, better mechanical properties of RGRT were attained in the case where less main chain degradation occurred during the devulcanization process. The revulcanized sample obtained from the barrel reactor having flow rate of 6.3 g/s shows a tensile strength of 8.7 MPa, elongation at break of 217 % and

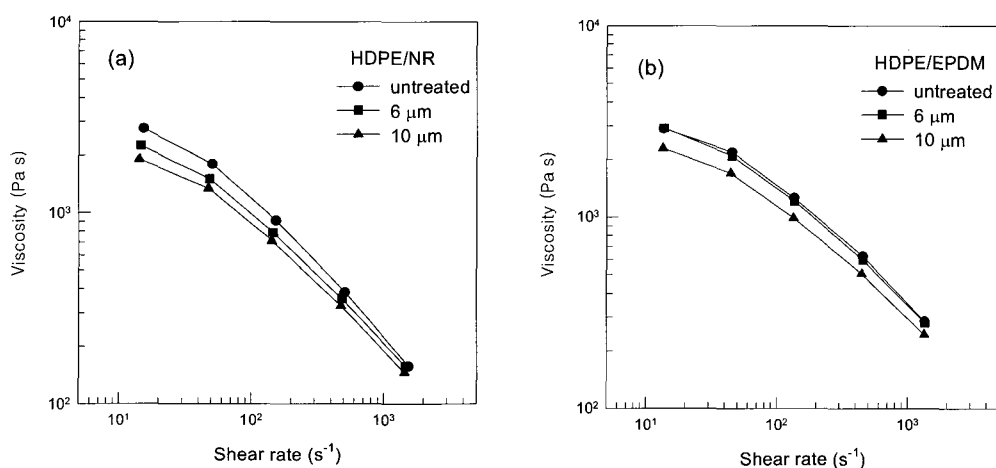
modulus at 100% elongation of 2.6 MPa. The productivity of the barrel reactor is higher than the coaxial reactor. In addition, the mechanical properties of the sample obtained using the barrel reactor at the higher flow rate, which cannot be achieved in the coaxial reactor, were higher. These properties meet the higher level of specification made for tire reclaim.<sup>23</sup> The samples showing inferior performance were considered over-treated. The over-treatment means a higher degree of devulcanization along with a significant degradation of the backbone molecular chains. The overtreated samples were usually softer and more sticky.

## 2. In-situ Compatibilization

### 2.1 Plastic/Rubber Blends

Various plastic/rubber blends were ultrasonically treated. It was found that higher is the ultrasonic amplitude, more is the chain rupture or degradation taking place, and more is the power needed to carry it out. Also, it is observed that the die pressure decreases with increasing amplitude. This can be explained as the combined effect of chain breakup in the die gap and reduction in friction due to ultrasonic vibrations.

The flow curves of untreated and ultrasonically treated HDPE/NR and HDPE/EPDM blends at 180°C.



**Figure 8.** Flow curves of untreated and ultrasonically treated HDPE/NR (a) and HDPE/EPDM (b) blends at 180°C.



**Table 1. The mechanical properties of untreated and ultrasonically treated blends.**

Blend		Tensile Strength MPa	Elongation at Break, %	Young's Modulus MPa	Toughness MPa	Impact Energy Joule
PP/NR	Untreated	8.39	38.9	191.0	2.99	2.75
	6 $\mu\text{m}$	11.27	111.7	250.0	12.19	5.89
	10 $\mu\text{m}$	10.60	126.8	215.0	13.19	3.52
PP/EPDM	Untreated	9.87	29.1	229.0	2.68	8.40
	6 $\mu\text{m}$	10.51	87.6	261.0	9.00	9.46
	10 $\mu\text{m}$	10.48	121.2	278.0	12.53	8.89

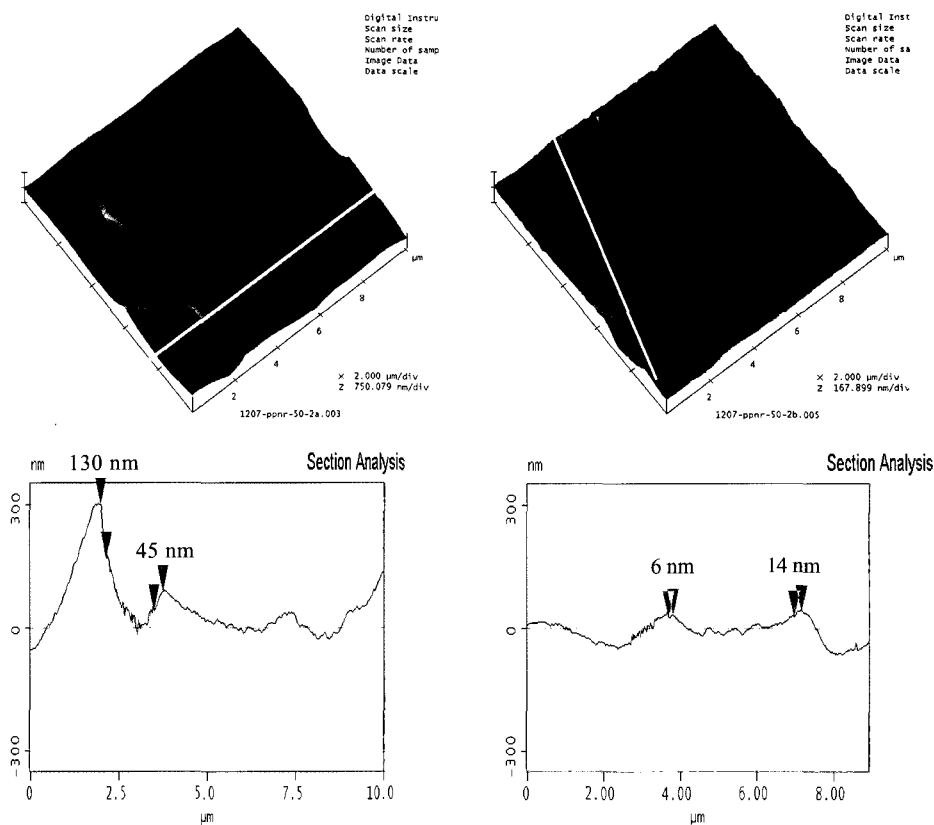
different ultrasonic amplitudes are presented in Figure 8. It is seen that the viscosity of the ultrasonically treated blends is lower than that of untreated blend for all blends. Also, the viscosity of ultrasonically treated blends decreases with an increase in ultrasonic amplitude. The decreased viscosity is an indication that the breakup of main chains occurs during extrusion with the imposition of ultrasonic waves. This observation is in accord with the ultrasonic power consumption and our earlier findings during ultrasonic-assisted extrusion of homopolymers<sup>24,25</sup> and ultrasonic decrosslinking.<sup>4-12</sup>

The mechanical properties of untreated and ultrasonically treated PP/NR and PP/EPDM blends are given in Table 1. It is seen that ultrasonic treatment of the blends during extrusion significantly increases the tensile stress, elongation at break, Young's modulus and toughness of each blend as compared to the untreated blend. It is believed that ultrasonic treatment of the blends enhances intermolecular interaction and possibly makes chemical bonds between dissimilar polymers creating copolymer without use of any chemicals. The breakage of the C-C bond during ultrasonic treatment can lead to the formation of long-chain radicals. Possibly, the macro-radicals from the two polymers in the blends may recombine with the formation of copolymers during ultrasonic treatment. It was reported earlier<sup>26,27</sup> that, in aqueous solution of heterogeneous systems, the block copolymerization could be initiated by free radicals produced by ultrasonic waves after pro-

longed treatment. Also, the improved mechanical properties are believed to result from *in-situ* compatibilization by copolymers created at the interface between dissimilar polymers and the vicinity during a very short time (in the order of seconds) of ultrasonic treatment under high pressure and temperatures. It is believed that these copolymers lead to the improved adhesion between two dissimilar polymers and also better dispersion of polymers in the blends. These effects are believed to be a major reason for enhancing mechanical properties of ultrasonically treated polymer blends. It is seen that the impact properties are increased by ultrasonic treatment. The impact energy, given by the area under the force-displacement curve, of ultrasonically treated blend is considerably higher than that of untreated blend. It is believed that impact properties are improved due to *in-situ* compatibilization by copolymers created during ultrasonic treatment.

The results obtained in an extraction experiment support the belief that copolymers are created through ultrasonic treatment of the blends. In this experiment, benzene was used as a solvent to dissolve NR portion in the NR/SBR blend. It was found that 49.8% of untreated blend was not extracted indicating that the initial NR content (50%) was dissolved in benzene. In contrast, 56.1% of ultrasonically treated blend at 6  $\mu\text{m}$  and 54.1% of treated blend at 10  $\mu\text{m}$  were not extracted. It can be thought that PP-NR copolymer, created during ultrasonic treatment, could not be dissolved or extracted by benzene. Accordingly, it is believed that this copolymer created during ultrasonic treatment led to compatibilization and the improved mechanical properties of the blend. The amount of copolymer is higher at lower amplitude. Possibly, at higher amplitude, due to the more degradation, the non-extracted fraction and therefore the amount of copolymer is lower.

The 10  $\mu\text{m}$  phase images of untreated and treated PP/NR blends obtained by the AFM are shown in Figure 9. It is seen that in the untreated blend a



**Figure 9.** The AFM phase images of untreated (left) and ultrasonically treated (right) PP/NR blends.

sharp step ranging between 45 and 130 nm is present between the PP and NR phases. However, a smooth step ranging between 6 to 14 nm is observed in the treated blend. Therefore, the AFM study revealed the presence of a transition interface layer between plastic and rubber phases in the blend.

The SEM photomicrographs showing morphologies of untreated and ultrasonically treated PP/NR and PP/EPDM blends with and without annealing are given in Figure 10. As seen, for all blends the rubber is dispersed phase. Also, before annealing there is no major differences in morphology between plastic and rubber phase in untreated and treated blends. However, after annealing the domain sizes of ultrasonically treated blends are much smaller than that of untreated blends. It is believed that during annealing the retardation of phase growth in

the treated blend takes place and its morphology becomes more stable than that of the untreated blend due to the copolymer created during ultrasonic treatment. Therefore, the reason for the enhanced mechanical properties in the ultrasonically treated blends is the presence of the *in-situ* created copolymers leading to enhanced chemical interaction at the interface and improved adhesion between dissimilar polymers in the blend.

## 2.2 Rubber/Rubber Blends

Figure 11a shows the molecular weight distribution of untreated and ultrasonically treated NR/SBR blends. As seen in Figure 11a after ultrasonic treatment the appreciable tails of high molecular weight part was generated in the NR/SBR blend, a peak of the molecular weight distribution

## PP/NR blends

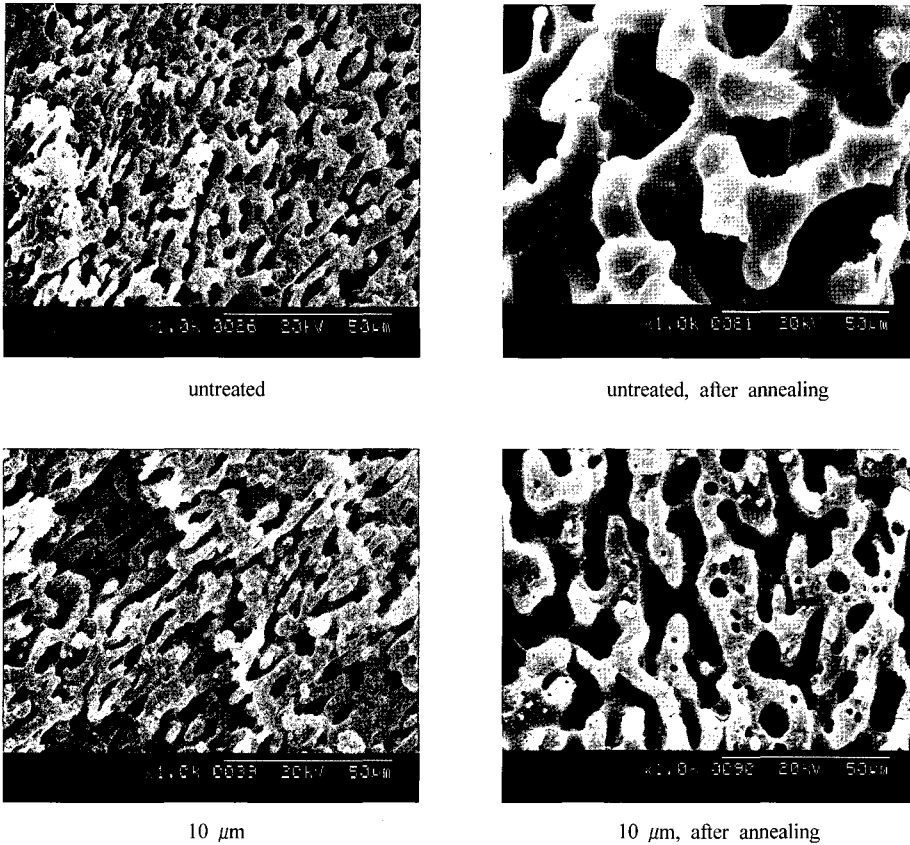
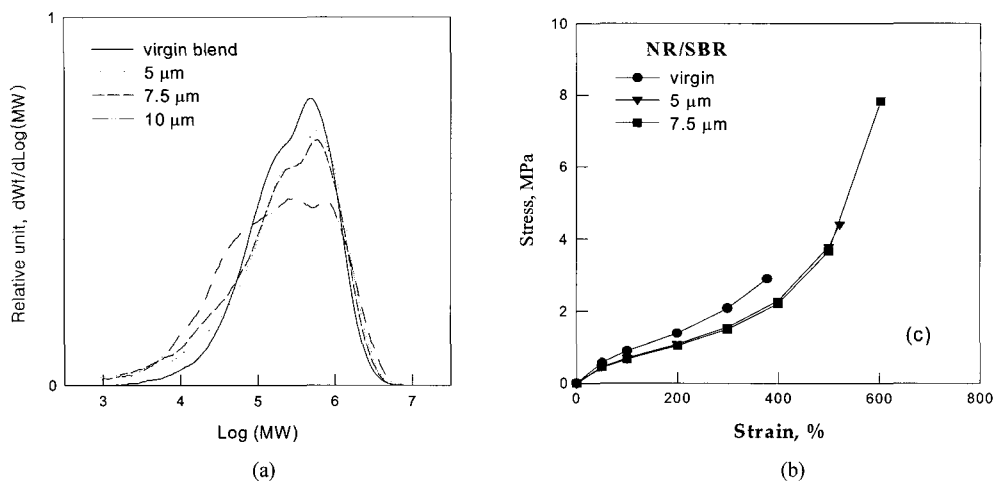


Figure 10. SEM photomicrographs of untreated and ultrasonically treated PP/NR blends.

curve was shifted to a higher molecular weight values. Also, the molecular weight distribution was broadened after ultrasonic treatment. The increases in the weight and z-average molecular weights were a clear indication of the creation of copolymer during ultrasonic treatment of the blend. It is believed that long chain radicals in the blend, formed by ultrasonic action, recombined with each other during ultrasonic treatment leading to the formation of copolymers and the increase of molecular weight. These copolymers were obtained for pairs of polymers which otherwise cannot be copolymerized. This process of *in-situ* copolymerization could open a route to make new copolymers from practically any pairs of existing elastomers to achieve desirable

chemical and physical properties.

The most remarkable effect of ultrasonic treatment was seen on mechanical properties. Figure 11b shows the stress-strain curves of vulcanizates prepared from untreated and ultrasonically treated NR/SBR blend. The tensile strength and elongation at break of the ultrasonically treated blend were significantly improved, especially at 7.5  $\mu\text{m}$ . It is believed that ultrasonic treatment of the blends enhanced intermolecular interaction, improved adhesion and made chemical bonds between polymers creating copolymer without the use of any chemicals. Possibly, the NR/SBR copolymer was created at the interfaces and their vicinities during the very short time (in the order of seconds) of ultra-



**Figure 11.** Molecular weight distribution (a) and stress-strain curves (b) of untreated and ultrasonically treated NR/SBR blends.

sonic treatment under high pressures and temperatures. This ultrasonic *in-situ* copolymerization during extrusion is believed to be a major reason for enhancing the tensile strength and elongation at break of the NR/SBR blend. Uniquely, this process could be applied for preparing plastic/rubber blends to make thermoplastic elastomers or novel rubber/rubber blends and to make novel copolymers with desirable chemical and physical properties.

#### IV. Summary

The present paper is devoted to recent advances in ultrasonic devulcanization technology of vulcanized elastomers and to a new field of study of ultrasonic *in-situ* copolymerization and compatibilization of polymer blends. In particular, various issues related to ultrasonic recycling of rubbers are discussed including modern methods and processes developed in our laboratory. Major emphasis is made on ultrasonic devulcanization of used tires and various rubber wastes. Machines developed in our laboratory to carry out devulcanization process along with processing characteristics of various vulcanized rubbers are described. Curing, rheology and structural characteristics of devulcanized rubbers

are presented. Mechanical properties of various re-vulcanized rubbers are measured and compared with those of virgin vulcanizates. The devulcanization model proposed by us and based on the presence of ultrasonic cavitation in rubbers is discussed and comparison of the predicted results with experimental data is made. In addition, a possibility of carrying out *in-situ* segmental copolymerization process of immiscible polymer blends in melt state during extrusion with aid of high power ultrasonic waves, recently discovered in our laboratory, is discussed. The process takes place at a very short time and leads to significant enhancement of the mechanical properties of the blends and stabilization of their morphology. Data obtained by a solvent extraction, indicating reduction in the amount of the extractable component, gel permeation chromatography, indicating formation of the high molecular weight tail, and scanning electron microscopy micrographs, indicating stabilization of the phase morphology in the melt state of the ultrasonically treated blends point towards the occurrence of *in-situ* copolymer formation. This new technology for segmental copolymerization is suitable for compatibilization of polymer blends without use of any chemicals.

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