manufacturers and further cascading to raw material suppliers such as Birla Carbon.

These norms are expected to further develop over the coming years with a dynamic shift expected in the composition of tires and tire manufacturing over the next 10 years and beyond. Further, the future of "mobility" will no doubt be different utilizing competing drive trains of different technology to reduce emissions and improve fuel economy, whether from hydrocarbon-based fuels or electricity. Thus the passenger car market continues to be driven by fuel efficiency with beginnings of environmentalism as differentiators by car manufacturers and the growth and marketing of green/hybrid vehicles are growing stronger and louder (Sale of Green/Hybrid Cars). Today, "green" may still not be the overriding decision factor while purchasing an automobile, but it may not be too far out in the future. Fuel efficiency, driven by rising fuel costs may still be the primary decision factor, but the consumer is quick to deduce choosing higher fuel efficiency is also being an environmentally responsible consumer.

So what role will tires play in driving and supporting the green technologies currently being sold and developed for the future? Research indicates that up to 20% of a vehicle's fuel efficiency is impacted by its tires as imparted by the tires' rolling resistance. At typical tire operating temperatures of approximately 60°C, this rolling resistance can be dictated by the tires' heat buildup properties inherent in viscoelastic materials such as rubber, when reinforced with a reinforcing agent like Carbon Black. All components of a tire contribute to its "heat buildup properties", but the tread, being in contact with road surface and undergoing more significant dynamic deformation, contributes >50% of a tire's rolling resistance (see Figure 1 below). Thus it is extremely important to focus on the one compound with the highest heat buildup and rolling resistance to achieve differentiated performance for

Tire Component Contribution to Rolling Resistance

Figure 1 shows tire components and their relative contribution to rolling resistance. Note the tread compound is responsible for the majority of a tire's rolling resistance. Most development work is geared toward reducing heat buildup in the tire tread compound.

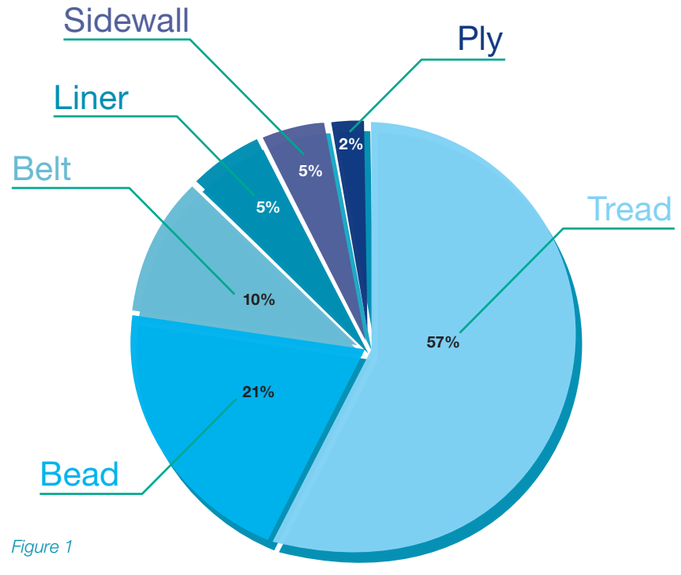

Figure 1

a tire. Low rolling resistance has been and has become an ever-increasing area of investment and technological development for tire manufacturers in all aspects of tire technology including design, construction and materials. Birla Carbon can play a role in the materials area and that is where our efforts have been focused – designing new composite technology for low rolling resistance (low heat buildup) tread compounds.

> Tire rolling resistance is directly related to the amount of wasted energy or fuel that a tire consumes when rolling under load due to repeated dynamic deformation and heat buildup in the tire.

Development of the Birla Carbon Solution for Green Tire Technology

Since over twenty years ago when Michelin introduced the first patent for a low rolling resistance tire containing silica as a reinforcing agent, the use of silica has continued to grow and has now become a widely adopted technology by practically all major tire manufacturers. Numerous efforts by Carbon Black companies to find a suitable alternative have been unsuccessful, and silica use, while only about 5% of filler volume used in tire treads, has started to become a threat to our Carbon Black business. However, silica compounds are higher cost, take longer to mix and reduce a tire factory throughput dramatically. Considering all the above factors, a clear need/opportunity exists to provide a completely differentiated Carbon Black to counter the silica threat and improve Birla Carbon's profitability, improve tire performance and our customers' manufacturing throughput, cost structure and profitability.

Understanding this need and envisioning this to be a primary driver of technological investments of the future, in 2008 the technology team at Birla Carbon proactively took up the challenge of finding a solution to this emerging need. Led by Dr. Charles Herd, the team adopted a unique approach for this project. Instead of collaborating with the tire manufacturers, the team reached out to three different material suppliers to the tire industry – a leading polymer manufacturer, and two other materials manufacturers outside the realm of Carbon Black and polymers, but that cannot be identified due to confidentiality agreements. The goal and strategy being that Carbon Black alone could not solve the problem, rather a combination of two unique materials would be required to achieve the truly differentiated performance needed for a green tire based on Carbon Black as a reinforcing agent as opposed to silica.

What followed was a successful collaboration with the polymer manufacturer – Lanxess, a truly global player in the elastomer business for tire and non-tire applications, bringing together two unique materials – a surface-modified Carbon Black for rubber and a new technology elastomer designed by Lanxess that is a functionalized elastomer. With our extensive infrastructure in place, the team had all the requisite capabilities and equipment to undertake this development. The companies entered into a joint development