ERJ Future Tire & Rubber Awards 2024

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Name and contact details of person submitting the entry

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Please indicate if we can contact you to request further information about this entry

- Yes, by email

Company/companies (lead customers, suppliers etc) involved in the project or innovation. (Where possible, please give location details.)

Cabot Corporation with pilot scale production at Cabot's Pampa, Texas, facility.

Which category or categories in the FTR24 Awards does this entry apply to?

- Innovative materials science
- Research & development

Please give a title for the project or innovation?

Reclaimed Carbon Surface Regeneration to Achieve Equivalent Performance to Reinforcing Carbon Black

Q1. Please summarise the main benefits of this development for the tire and/or rubber industry

Increased circularity and reduced environmental impact across the value chain – including greenhouse gas (GHG) reduction and further use of circular or renewable content – has become a driving force for tire manufacturers. Cabot views sustainability both as a responsibility and a business opportunity and is intensely focused on new product and process sustainability to address tire manufacturer's needs.

The tire industry is particularly interested in recycling end-of-is tire pyrolysis, reclaimed carbon (rC) that – while looking like carbon black – is not carbon black. rC is performance deficient due to being a blend of the carbon blacks in the tires, having 15-20% non-carbon content, large agglomerates, and a particle surface with inferior interaction with rubber. It can only be used at low loadings (for example, up to 10% of filler) and in limited parts of

the tire. Higher than 10% rC loadings can impact in-rubber performance in certain tire parts. As in-rubber performance is critical to safety, comfort and longevity of the tire, manufacturers are unwilling to accept this reduction in in-rubber performance, therefore performance upgrades to rC are essential for use at higher loadings and in more tire parts.

Cabot's project addresses this challenge in an innovative way, and the technology involved is covered by a set of broadly granted patents. It delivers regenerated carbon that achieves equivalent performance in the reinforcing space; no other similar sustainable carbon black substitutes are available on the market today. It stands out against conventional rC and competitive rC upgrade products because it can provide ASTM N300 series level reinforcement and increased loading. Furthermore, the loading of this regenerated carbon can be up to 30% of the total filler, improving the sustainable content while maintaining equivalent in-rubber performance, and enabling the tire industry to increase sustainable content in performance critical tire applications.

Q2. What are the main technical advances involved?

Reclaimed carbon black available on the market today has several challenges to larger scale adoption due to:

- Charred surface with low activity which makes it difficult to interact with elastomers

- Board particle size distribution, with large agglomerates, which creates in-rubber failure points

- Unreliable performance which makes it difficult to formulate

- Highly variable ash levels which leads to low consistency

Current processes for upgrading rC (blending, de-ashing, etc.) may address one or several of these challenges, but they fail to deliver the overall in-rubber performance to meet key application requirements. Cabot's Reclaimed Carbon Surface Regeneration technology improves the surface reactivity of the final product, thereby improving the overall in-rubber performance so that rC behaves similarly to virgin carbon black in rubber compound formulations. In addition, the final product has improved dispersion versus rC. To manage the ash level and inconsistency in rC, Cabot is closely engaged with suppliers to align on incoming rC specifications and testing methodologies to ensure that Cabot delivers a final regenerated carbon product that has consistent performance.

Other companies working to upgrade rC – of which there are very few – have only been able to demonstrate capabilities based on lab-scale testing. Our technology has been deployed at pilot scale achieving multiple trial runs, which has enabled us to more closely replicate what the process and product performance may be at commercial scale.

Q3. Which technical challenges did the development team overcome to deliver this project?

The process required significant development time to determine the technology capabilities, flexibility, and process controls to deliver a consistent product with increased sustainable content to our customers.

To even test the concept, the pilot plant required materials handling innovation, testing of options, and a small capital project to install new equipment.

As with any development project, the technical team learned a lot about the technology with each pilot plant production run. For example, the initial products produced did not disperse or perform well in rubber. This led to a revised pilot process configuration. The team also leaned heavily on various statistical tools to establish the optimal process conditions for regenerating the rC. After multiple trials, the process has now been expanded to pilot scale.

Q4. Please provide data showing the scale of improvement(s) achieved across the key, target metrics/parameters of this project

We have evaluated the potential for both 20% and 30% rC loadings in our final products.

Our technology results show that at 20% rC loading we can improve both the dispersion and tensile properties of rC to better align with N330 performance. For the 20% loading analysis we compared the performance of two Reclaimed Carbon Surface Regeneration products to N330 and rC dry blends. The difference between “20% rC Upgrade 1” and “20% rC Upgrade 2” is the process conditions. As shown by “20% rC Upgrade 1” the technology can achieve tensile properties similar to N330, while “20% rC Upgrade 2” shows the ability of the technology to tune rigidity to meet specific application or customer needs. The dispergrader results show the technology’s capability to improve dispersion by ~35-40% versus rC dry blends.

Our results show that at 30% rC loading we can improve both the dispersion and tensile properties of rC rubber composites to improve performance for reinforcing applications. We compared the performance of our Reclaimed Carbon Surface Regeneration product to N330 and rC dry blends. As shown by the “30% rC Upgrade” trace, the technology can improve the tensile properties of rC dry blends at equivalent loading. The dispergrader

results show the technology's capability to improve dispersion by approximately 25-40% versus rC dry blends.

Q5. What is the commercial status of the technology or product?

The technology has been deployed at our pilot plant in Pampa, Texas. From the pilot line, we have sampled prototype products to multiple tire customers in Europe and North America. Our customers have shown high interest due to the technology's ability to achieve equivalent in-rubber performance to reinforcing grades of carbon black – not achievable with existing technologies on the market today. We are highly engaged with customers to align on the next steps for commercialization.

Q6. Scope for further enhancements to the technology or product

Enabling sustainability through increased sustainable content and lower GHG emissions continues to be a development focus at Cabot. This technology is the first pilot-scale technology to demonstrate rC upgrading capabilities to enable use in reinforcing applications. We continue to evaluate how we can leverage this technology to increase the sustainable content in our products.

Even though the dispersion is better than rC, we are evaluating pathways to further improve the dispersion to better align with N330. In addition, the industry needs sustainable product options for reinforcing grades, therefore we continue to explore technology to upgrade rC to further increase rC loading and performance.

In addition, the project team is focused on delivering more sustainable materials without sacrificing performance and at competitive economics.

Many thanks for completing the FTR24 Awards entry form. You can add further information here and/or email supporting information to ERJ Editor: praleigh@eurorubberjournal.com

Question skipped