Sustainable Fillers for Future Elastomers

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Sustainably Meeting Tomorrow’s Challenges
Agenda

- Who are ARTIS?
- Elastomers for Tyres
- Sustainable Compounds
- rCB and Pyrolysis
- rSilica
- ARTIS SMG
ARTIS Overview

Independent Materials Consultancy

Centre of materials expertise
Point of contact for advice
Partnerships for Collaborative R & D
Specific consultancy projects

Target to establish ARTIS as the world leader for the research and development of pyrolysis derived fillers

Developing an expertise in more general material recovery and sustainable rubber
Tyre usage

• “World demand for tires is projected to rise 4.1 percent per year to 3.0 billion units in 2019 and a value of $258b”

22% Increase !!

How are we going to meet this need?
End of life options

• Dumping
• Shredding
• Landfill Engineering
• Fuel – cement kilns
• Rubber powder

• Devulcanisation

• Pyrolysis
Tyre Sustainability

• What’s in a tyre?
  – Rubber compounds – maybe 15
    • 15 ingredients per compound
  – Steel – high tensile, high value
  – Fabrics – nylon, polyester

• Which bits are sustainable?
  – Most components
  – Polymers, fillers, oils, chemicals

• Sustainability agendas from tyre co’s?
  – All major tyre companies have sustainability agendas

• Focus on Manufacture, use, end of life
  – Reduced energy consumption, better performance, re-use
  – Carbon Credits, sustainable materials, CO2 reduction in use
Bridgestone are aiming for 100% sustainable tyre, **Has been achieved**
Most others will be looking at same issues and probably also achieved it
We will produce other 100% sustainable compounds
Sustainable materials

- Polymers
  - Replacement of NR with Guayule, dandelion derived materials
  - Butadiene sourced from Biomass
- Oils – from biomass and bio sourced
- Fillers – from Biomass (carbon)
  - Alternatives e.g rice husk silica, hydrothermal and veg derived carbon
  - Egg and Tomato
- Where do they impact?
  - Major impacts on performance
  - Requires very specific compounds
  - Good results are achievable
  - Recyclability?
Filler requirements

• Fillers $\rightarrow$ mechanical strength

• Filler use in Tyres set to rise 15% by 2020

• Mixture of filler types
ARTIS and Pyrolysis

- Not new Technology
- Frequently classed poor quality
- Benchmarked 2014, repeat 2016
- Good quality material is available
ARTIS and Pyrolysis

- Generation of a unique material
- Not carbon black as we know it!
- Formed “in-situ” not simply recovered
- Different surface activity

- Carbonaceous residue dictating:
  - Surface Activity.
  - Dispersibility.

- Both reduce reinforcing potential.

- We understand these differences and their impact
ARTIS and Pyrolysis

- Large discrepancies in composition
- Very different to Std Blacks
- Poor market perception
- High level variability
- Spec required to define performance

- rCB known to contain:
  - Originally compounded carbon black.
  - Carbonaceous residues formed during pyrolysis.
  - Inorganic materials.
Compounding trends

- Increasing utilisation of silica filler.
- Current, leading, passenger tyre treads contain very little CB. Same trend emerging for Truck and some other components/applications.
- Not a good feedstock for rCB production!
rSilica Process

- rSilica yields >30% achieved with careful selection of the feedstock.
  - No post-reactor processing.
- Typically >95wt% silica.
- ~3-4wt% zinc oxide (active, so should be beneficial).
- <2wt% trace elements.
- The non-silica components were not accounted for in this study.

<table>
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<th>Element</th>
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<td>Si</td>
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<td>Zn</td>
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In Rubber Performance

- Slight reduction in dispersion compared to virgin highly dispersible Ultrasil 7000GR.
- Note: No post reactor treatment of rSilica.
- Best ‘refined’ rCB from crosscheck programme achieved Ra = 0.78µm.
- Note that Ra values for the tyre treads = 0.40 to 1.28µm.
In Rubber Performance

- Impressive performance compared to Ultrasil 7000GR control.
- **Note that rSilica is ~95wt% silica, therefore ~5wt% non-reinforcing.**
In Rubber Performance

- Greater level of filler-filler interactions with the 7000GR. $\Delta E' = E'_0 - E'_\infty$
  - 7000GR $\Delta E' = 7.48$
  - 50:50 $\Delta E' = 5.98$
  - rSilica $\Delta E' = 6.09$
- Reduced energy losses with ARTIS rSilica.
- ~5wt% non-reinforcing content of rSilica a significant contributor.
In Rubber Performance

- Slight reduction in stiffness, as noted previously.
- No statistically significant impact on $T_g$.
- Wet grip performance, therefore, expected to be similar.
Conclusions

- rCB and rSilica can offer green alternatives to conventional fillers. Recycling route dependent on feedstock composition.
- Predicted future growth of tyre production will demand raw ingredients from alternative sources.
- Potential for part or 100% replacement (formulation dependant).
- ARTIS currently pursuing ‘up-scaling’ and optimisation of the rSilica process.
A Sustainable Materials Community

End users

Processors

OEMs

Investors

Tyre recyclers
rCB: We are the Experts

• Actively contributing to ASTM D36 committee for carbon black


• Presenting the virtues of rCB to the rubber community and beyond (RubberCon, Tire Tech, Advanced Engineering Show, DKG, Materials World)

• 2\textsuperscript{nd} Major Benchmarking programme in 2016
  • Launched SMG Jan 2017

• Developing partnerships and collaborations going forward
• For those interested in sustainable rubber products

• Initial focus on recovered Carbon Black

• We will extend to other components such as silica

• We will provide guidance on the manufacture and application of sustainable materials and processes

• We will drive rCB quality standards

• We will improve the image of recycled materials through proactive partnerships

• Bringing together an international community of end users, tyre recyclers, OEMs and investors

• Grow the market for the benefit of all involved
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