Nachhaltigkeit und Wiederverwertung – Ein Überblick
Anke Blume & Fabian Grunert

DKG Regionalgruppe West – 28.10.2021 – Köln
Which are the biggest challenges when it comes to “Recycling” of elastomers?
1. Remove all chemical crosslinks $\rightarrow$ polymer can be re-shaped
2. Avoid breakage of the polymer chains (degradation) $\rightarrow$ avoid deterioration of properties
3. Receive single-origin material (separate all compound ingredients from each other)
4. Collect end-of-life rubber products
Ideally: After the recycling process crosslinks between polymer chains are removed → devulcanized material has same properties as original polymer.

Vulcanized Rubber = crosslinked polymer chains

Devulcanized Rubber = non-crosslinked polymer chains


**Reality**: During a recycling process only some (not all) crosslinks are removed and polymer chains are shortened as well (lower $M_w$)

→ Reclaimed material has worse properties than original polymer

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**Recycling**

**Elastomers - Challenges**

- Crosslink scission
- Polymer cleavage
- Intact crosslinks
- Physical entanglements
Recycling of elastomers is difficult, so what?!
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How big is the problem of scrap tires – is this really so severe?
If we would stack all scrap tires of 1 year on top of each other…
How high would that tower be?

A. Eiffel Tower (324 m)
B. Mount Everest (8,848 m)
C. ISS (408 km)
D. 2/3rd distance earth and moon (240,000 km)
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Recycling

Tires

Or in other words…
Recycling

Tires

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app. 1,000,000,000 tires per year
Collecting end of life rubber products:

1. 2/3 of all rubber products in the EU are related to tires

**GRG Production in Million Tonnes**

- **GRG**: General Rubber Goods

**Tyres Production in Million Tonnes**

- Source: ETRMA

Legend:

- 2017
- 2018

GRG: General Rubber Goods
Collecting end of life rubber products:
1. 2/3 of all rubber products in the EU are related to tires
2. Increasing interest in recycling of tires


- Disposal: 39% 20% 6% 5%
- Energy recovery: 6% 6% 7% 11%
- Export: 6% 6% 7% 11%
- Material recycling: 18% 27% 43% 50%
- Retreading: 6% 9% 12% 11%

Collecting end of life rubber products:

1. 2/3 of all rubber products in the EU are related to tires
2. Increasing interest in recycling of tires

**But:**
- Only “left-over” old tires can be collected
- Abraded tire material cannot be easily collected

→ Micro-plastic pollution of the environment
→ Up to 30 % of all micro plastic pollution is caused by tire wear particles!

Recycling

What are the current possibilities to recycle rubber?
Recycling
Technologies

Current ways to deal with end-of-life rubber products:
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- Disposal (e.g. landfill)
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Several houses

https://i.dailymail.co.uk/i/pix/2013/06/07/article-2337351-1A3275830000005DC-184_1024x615_large.jpg

https://s-media-cache-ak0.pinimg.com/originals/90/5f/2d/905f2d0ae14a363e91e634937093e99f.jpg
Current ways to deal with end-of-life rubber products:

- Disposal (e.g. landfill)
- Down-cycling (e.g. football fields)

https://www.riekepta.org/news/2016/3/12/c8hmq6cd2r1xv0dozeusa705sljcau

https://commons.wikimedia.org/wiki/File:All-weather_running_track.jpg
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https://www.ta-petro.com/blog/post/preventive-tire-maintenance-retreading
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- Devulcanization:
  - Selectively removing crosslinks
  - Use of devulcanization aids
  - Also possible use of bacteria
Goals to achieve

- Clean
- Bio-degradable
- Green ingredients
- Reusable
- Renewable
- Recyclable
- Non-toxic
- CO₂ neutral
- and many more…

Goals to achieve

Aim for the top!!

- Worn-out tires into new tires
- Material reuse
- Back to feedstock
- Energy recovery
Recycling is quite challenging.

How to make rubber more sustainable?
Sustainability

Research fields:
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- Green Tire Technology to reduce **rolling resistance** (fuel consumption) and improve **abrasion resistance** (lifespan)

https://www.plasticstoday.com

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- Green Tire Technology to reduce **rolling resistance** (fuel consumption) and improve **abrasion resistance** (lifespan)
- Retreading of tires (up to 7 times for truck and airplane tires)

![A retreaded tyre enables saving...](image)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Key Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>70%</td>
<td><strong>Ressource extraction</strong> (ore, oil...), mainly because of the avoided consumption of steel casings</td>
</tr>
<tr>
<td>29%</td>
<td><strong>Land use</strong> or growing hevea</td>
</tr>
<tr>
<td>24%</td>
<td><strong>CO₂ emissions</strong></td>
</tr>
<tr>
<td>21%</td>
<td><strong>Air pollution</strong> as measured by particulate matter emissions</td>
</tr>
<tr>
<td>19%</td>
<td><strong>Water consumption</strong></td>
</tr>
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</table>

...**compared to a low-end non-retreadable tyre**

*Source: Ernst & Young report: *The socio-economic impact of truck tyre retreading in Europe*
Sustainability

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- Retreading of tires (up to 7 times for truck and airplane tires)
- Green ingredients:
  - Vegetable oils to replace petrol-based ones
  - Bio-based polymers (Natural rubber tree, Russian dandelion, sugar cane, …)
  - Alternative fillers (e.g. lignin = paper pulp waste)
Sustainability

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- Recycling
  - Pyrolysis (reclaim of oil, carbon black, etc.)
  - Devulcanization (reclaim of all materials including the polymer)
Sustainability

All in all: We can be proud of that what we already achieved.

Let’s continue to become finally 100% sustainable.
Key Topics of ETRMA (https://www.etrma.org/key-topics/):

- Tire and Road Wear Particles
- Circular Economy
- Materials
- Mobility
- Industry Competitiveness (strategy)