Functionalized carbon black for elastomer composites with low hysteresis

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The meaning of this research

Tyre compounds represent the **most important application of rubber**.
The higher **environmental impact of tyres** takes place **during their use** and is due to rolling resistance.
Silica has brought a **revolution** in the field of elastomer composites: it allows mechanical reinforcement and a **great reduction of hysteresis and rolling resistance**. A **chemical bond between silica and the rubber chains** is established: **this is the key strength of silica!**
A **coupling agent** is used: an organosilane containing sulphur atoms. However, **silica** has various **drawbacks**: the **release of ethanol** from the silica – silane reaction, the **corrosion** of compounding equipment, the **increase of compound viscosity**, the **reduction of the shelf life** of semifinished products.
It would be **highly desirable** to **substitute** or at least **partially replace silica** with an alternative filler, obviously without damaging the composites' properties.

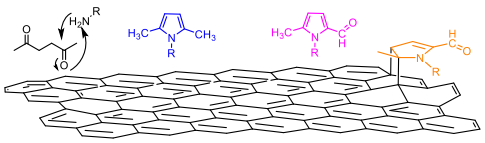
The objectives

☞ To prepare a CB-filled compound with the same performances of a silica-based compound

Hence

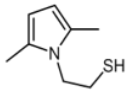
☞ To prepare a **functionalized carbon black** able **to establish a chemical bond with rubber chains**

Thanks to the pyrrole methodology for functionalizing carbon allotropes



How to achieve the objectives?

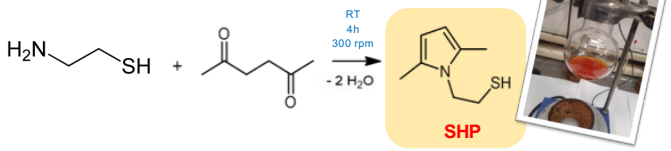
The selected pyrrole compound:



Thiol Pyrrole, SHP

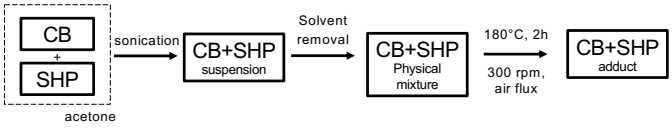
2-(2,5-dimethyl-1*H*-pyrrol-1- yl)ethane-1-thiol

Synthesis of SHP



The reaction was performed without catalysts and solvent

Preparation of CB-SHP adduct



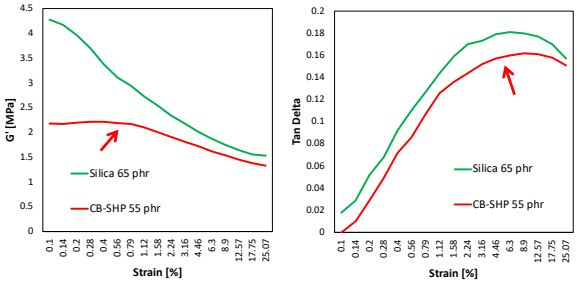
Preparation and characterization of rubber composites

65 phr Silica vs 55 phr CB-SHP

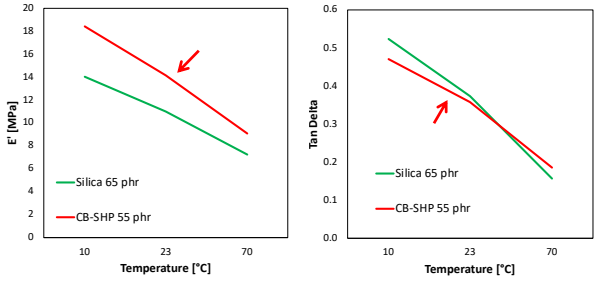
Recipies in phr	Silica 65 phr	CB-SHP 55 phr
S-SBR	70	70
NR	30	30
Silica	65	/
Silane	5.2	/
CB-SHP	/	55

Other ingredients used for each compound: stearic acid, ZnO, 6PPD, TBBS, PVI, sulphur

Study of filler networking in shear



Dynamic rigidity and hysteresis from axial compressive tests



Curves from axial and shear dynamic-mechanical analyses of S-SBR-based rubber composites filled with 65 phr of pristine silica (green) and 55 phr of CB-SHP (red).
55 phr of CB-SHP give similar results to 65 phr of silica.

Conclusions

- Composites with **functionalized CB, reactive with the rubber chains**, have the same or **even better** dynamic mechanical **properties with respect to silica –based** composites
- The **reactive CB** was prepared with the **pyrrole methodology**, through a simple and sustainable technology based on a pyrrole compound
- These results demonstrate that silica is not the only possible filler for the preparation of green elastomeric composites for tyre applications.

References:
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