Edge functionalized graphene layers for better ultimate properties of elastomer nanocomposites

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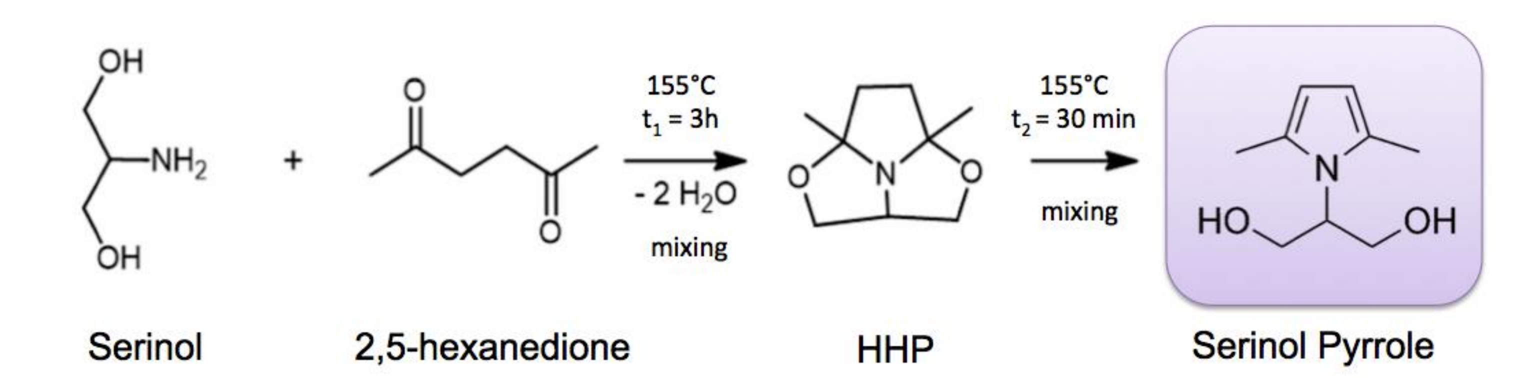
Objectives

☞To study the effects of an improved dispersion of high surface area graphite (HSAG) in natural rubber (NR) thanks to the functionalization of HSAG with Serinol Pyrrole (SP) and to latex blending.

☞Promotion of strain-induced crystallization

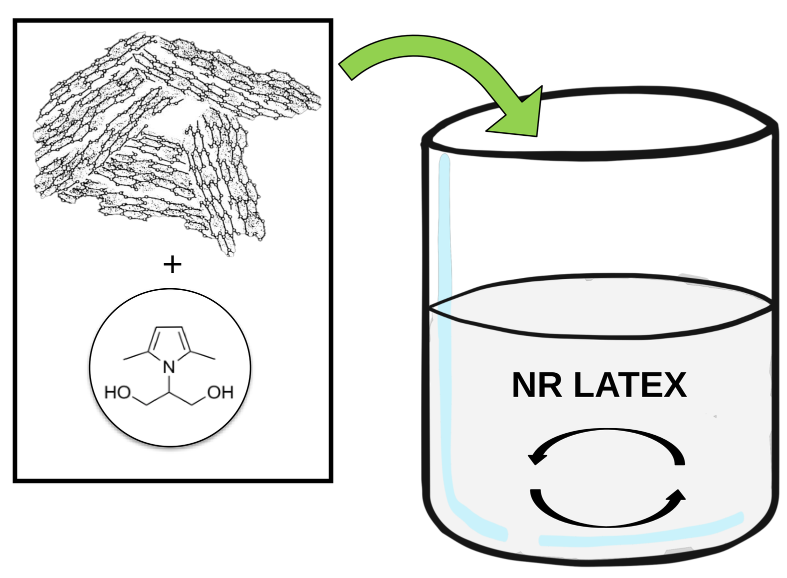
1) Synthesis of 2-(2,5-dimethyl-1*H*-pyrrol-1-yl)-1,3-propandiol (Serinol Pyrrole)



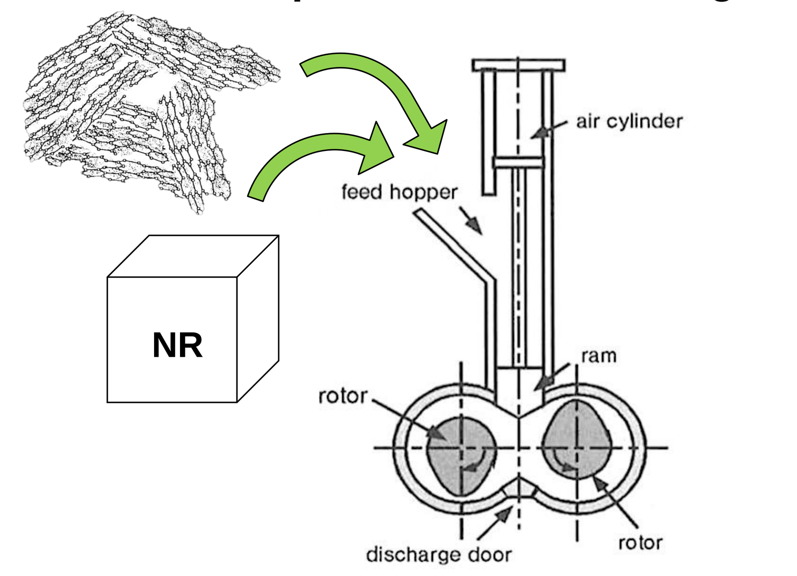
The reaction was performed using no catalysts and no solvent.

2) Preparation of the rubber composites

NR – HSAG-SP nanocomposites: latex blending



NR – HSAG nanocomposites: melt blending



3) Characterization of the rubber composites

Vulcanization curves

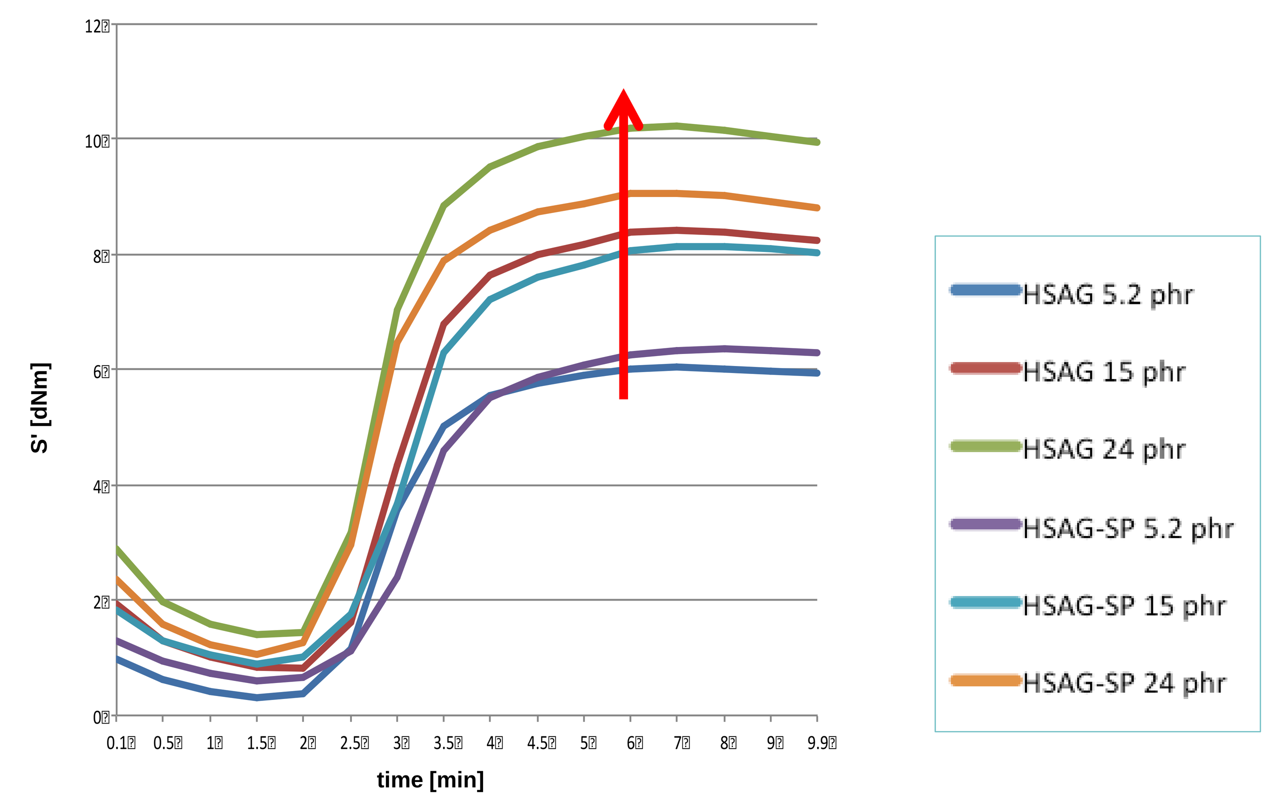
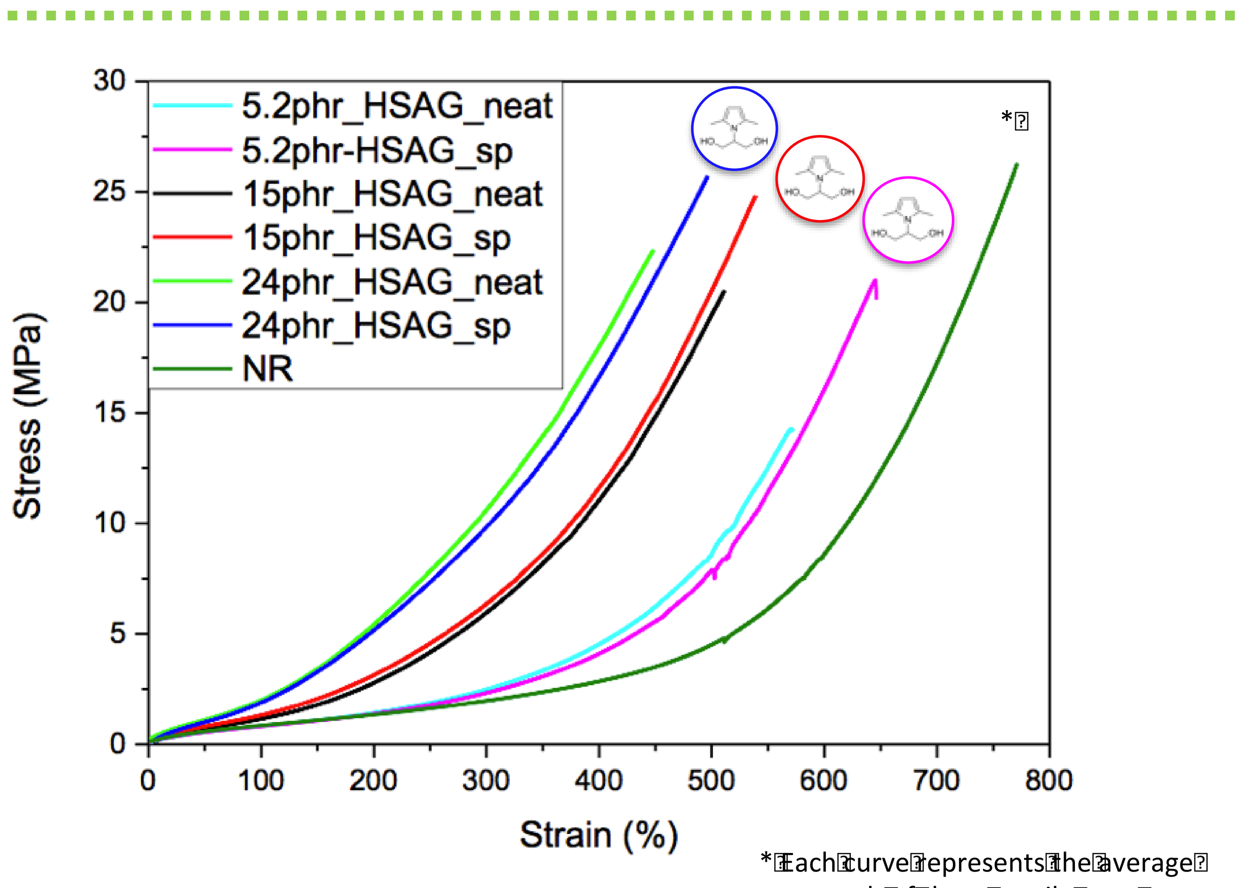


Figure 1. Increasing the content of graphite lower vulcanization induction time and higher MH values are obtained.

Tensile Tests



*Each curve represents the average result of three tensile tests

Parametres	NR	HSAG 5.2 phr	HSAG 15 phr	HSAG 24 phr	HSAG-SP 5.2 phr	HSAG-SP 15 phr	HSAG-SP 24 phr
σ_{50} (MPa)	0.57	0.56	0.69	1.05	0.54	0.8	1.03
σ_{100} (MPa)	0.82	0.84	1.15	1.92	0.8	1.31	1.9
σ_B (MPa)	24.47	13.6	21.39	24.31	19.57	23.13	25.35
ε_B (%)	760.02	561.2	516.53	468.69	633.69	536.07	493.01

SP

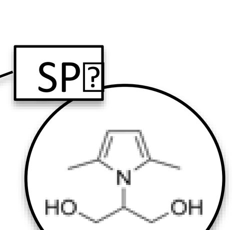
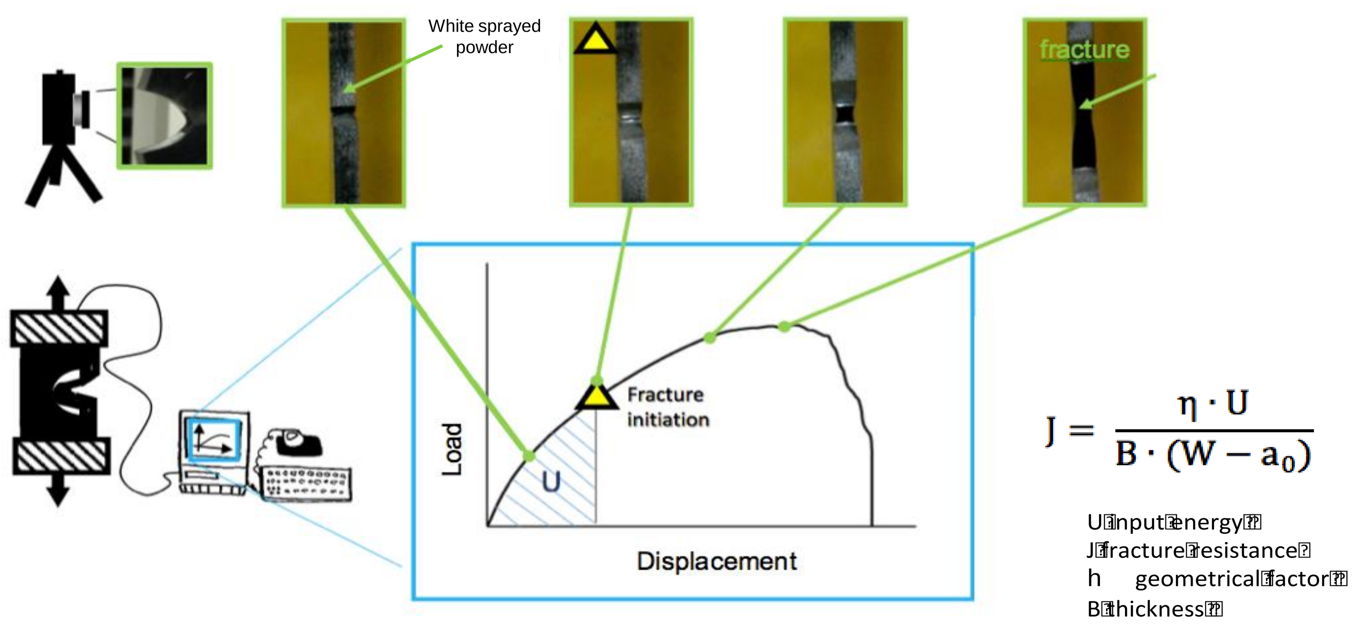


Figure 2. Tensile curves and corresponding tensile data show that HSAG-SP leads to better ultimate properties.

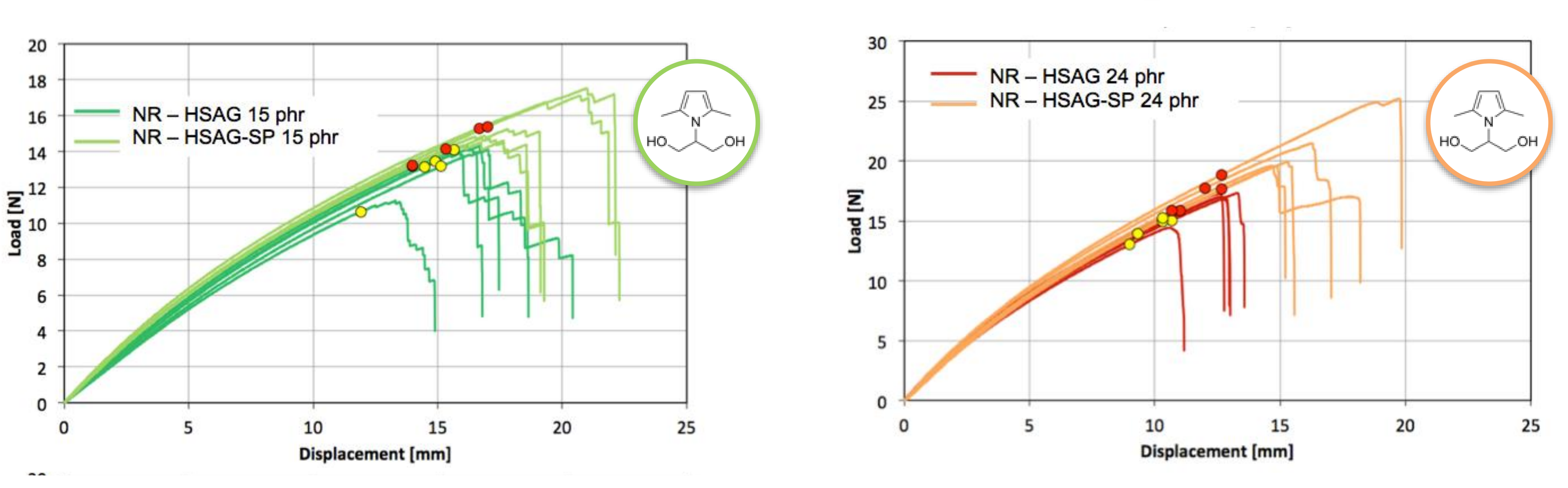
Fracture tests

A single specimen technique was used to calculate fracture resistance [4]:



$$J = \frac{\eta \cdot U}{B \cdot (W - a_0)}$$

U: input energy
J: fracture resistance
η: geometrical factor
B: thickness
W: width
a_0: notch length



Crack deviation

Parameters	NR	HSAG 5.2 phr	HSAG 15 phr	HSAG 24 phr	HSAG-SP 5.2 phr	HSAG-SP 15 phr	HSAG-SP 24 phr
J_c (KJ/m^2)	18.06	5.22	3.51	2.63	5.42	3.99	3.6

SP

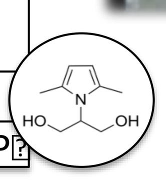


Figure 3. HSAG-SP leads to higher fracture resistance and, especially in the 24 phr sample, to crack deviation. In literature this deviation occurs in presence pf strain-induced crystallization [5]; therefore SP seems to favour this phenomenon.

Conclusions

In NR the functionalization of high surface area graphite (HSAG) with Serinol Pyrrole (SP) in combination with latex blending:

→ Leads to better tensile ultimate properties

→ Causes a higher fracture resistance

References:

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