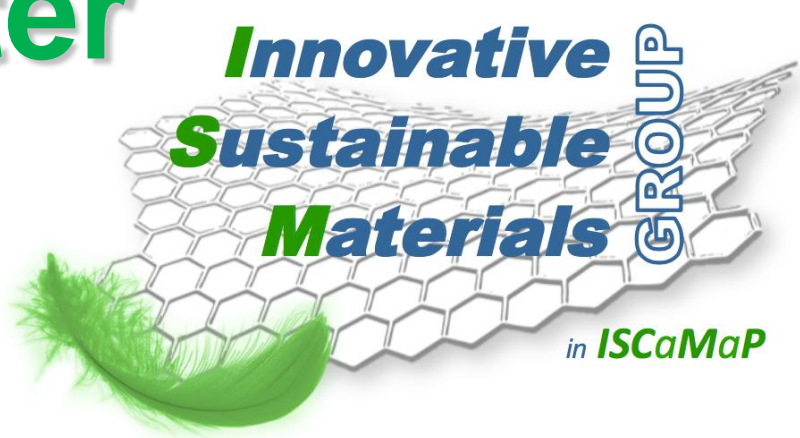




Sustainable materials for tyres. 1. Natural rubber compounds with better mechanical properties thanks to functionalized nanosized graphite



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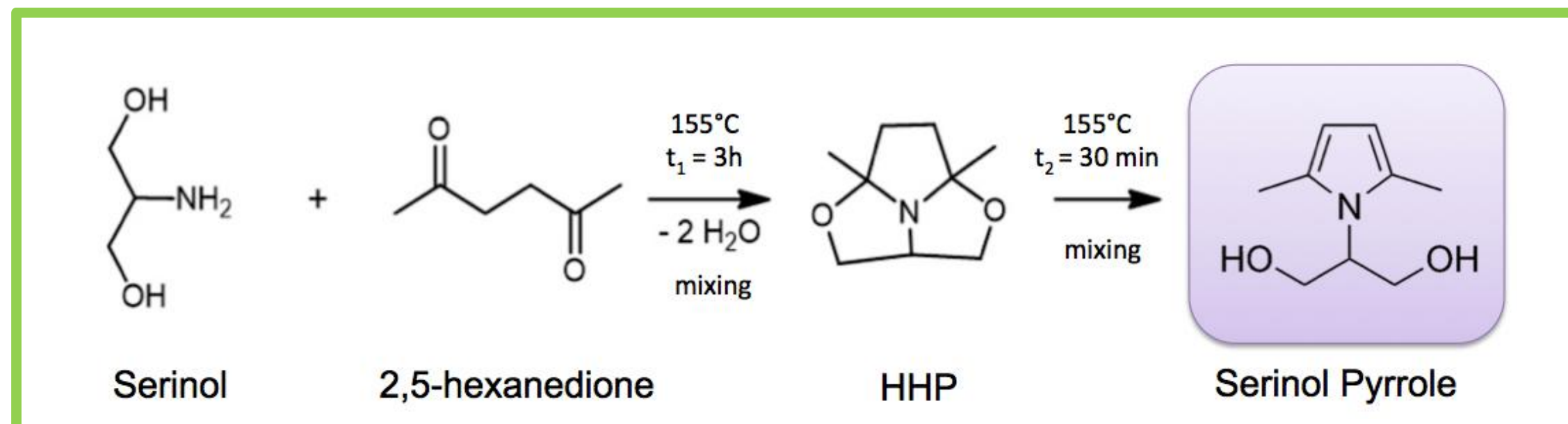
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Objectives

➔ 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.

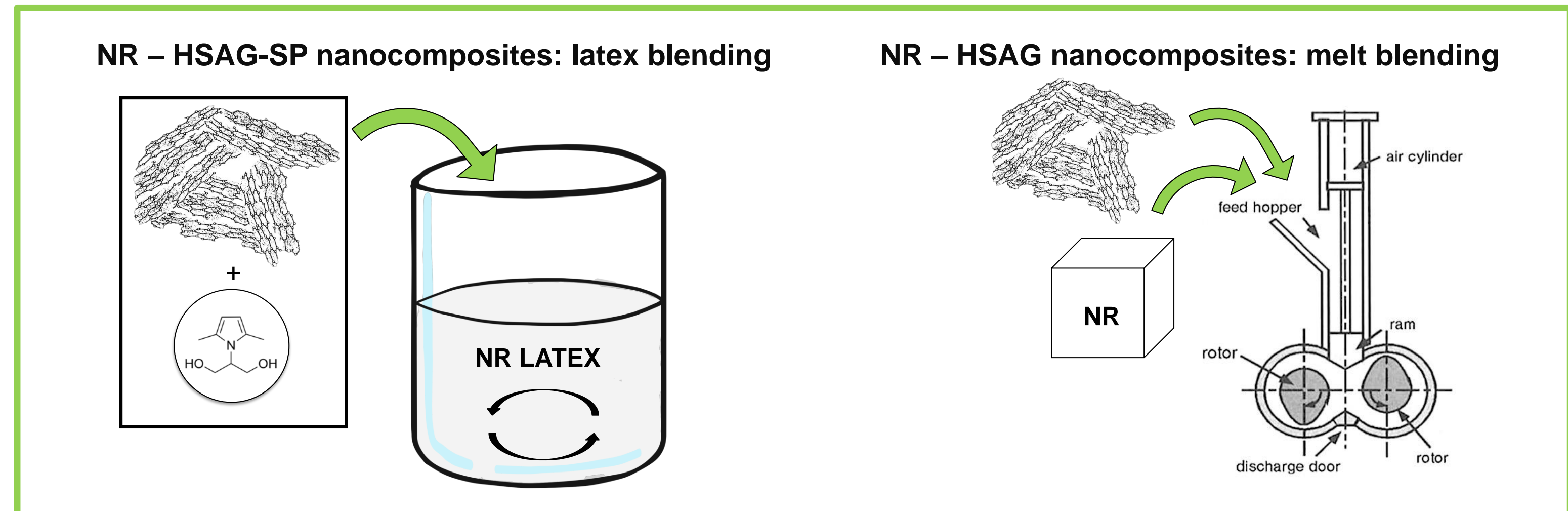
➔ Promotion of strain-induced crystallization

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



The reaction was performed using no catalysts and no solvent.

2) Preparation of the rubber composites



3) Characterization of the rubber composites

Vulcanization curves

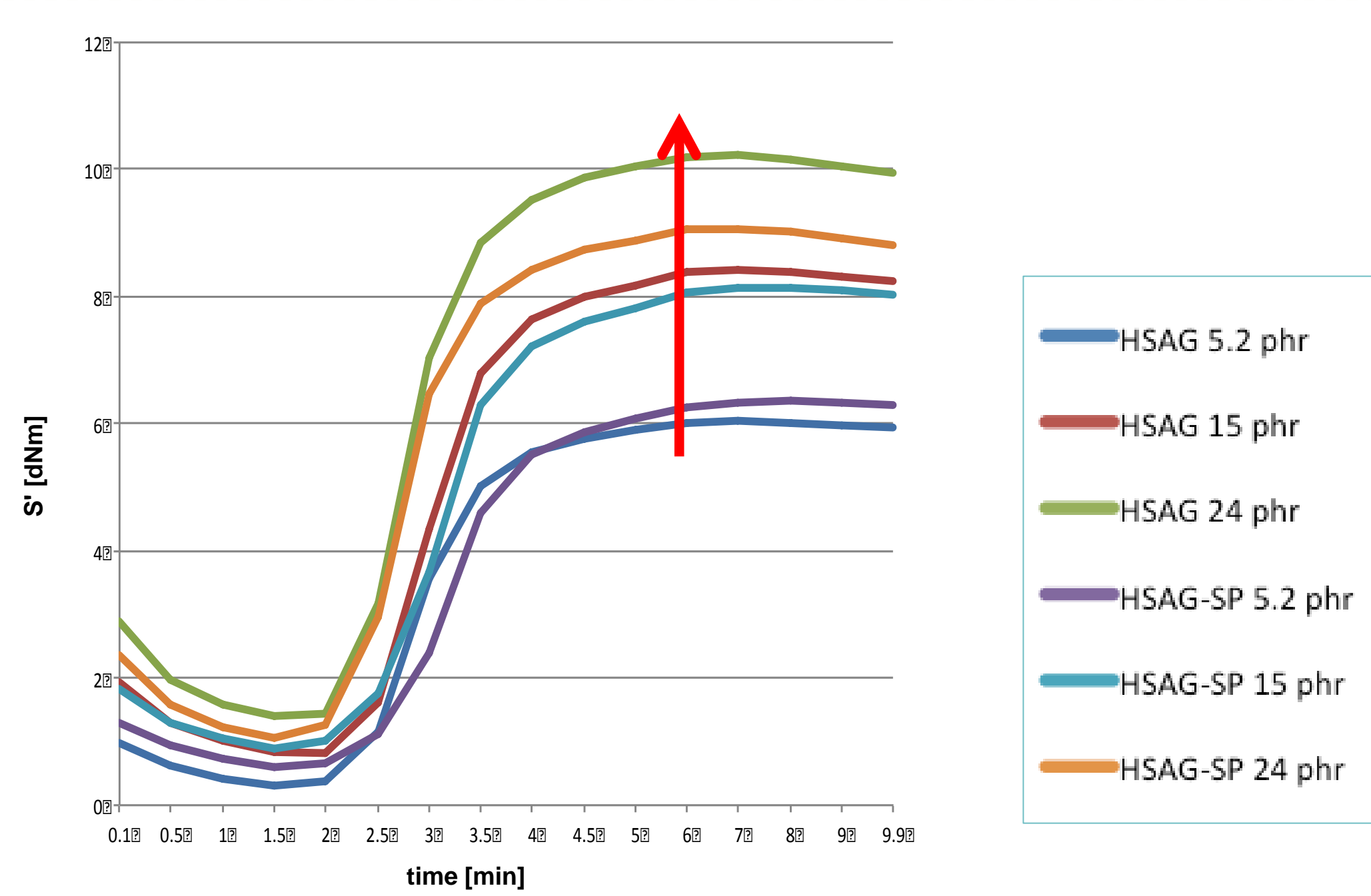
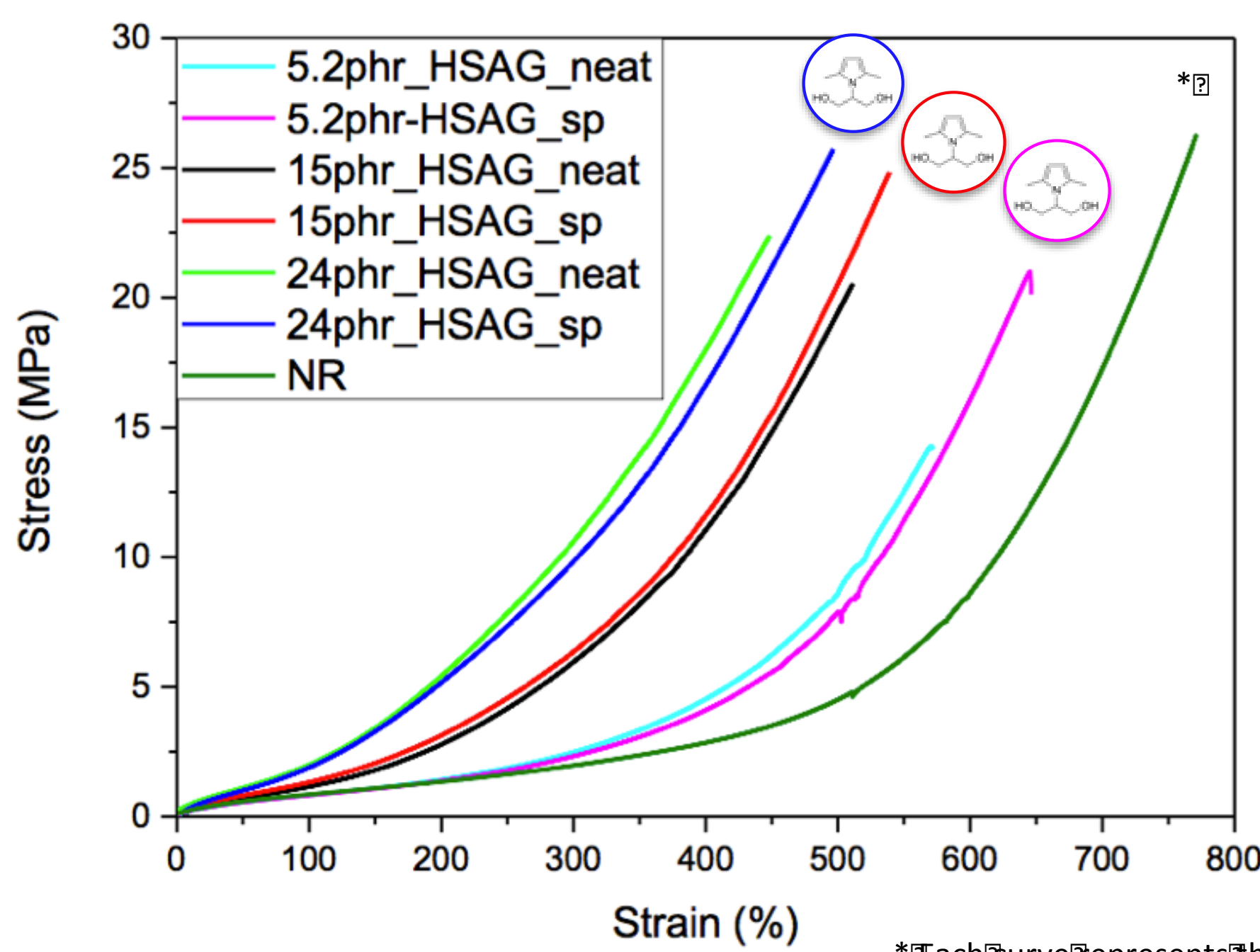


Figure 1. Increasing the content of graphite lower vulcanization induction time and higher MH values are obtained.

Tensile Tests

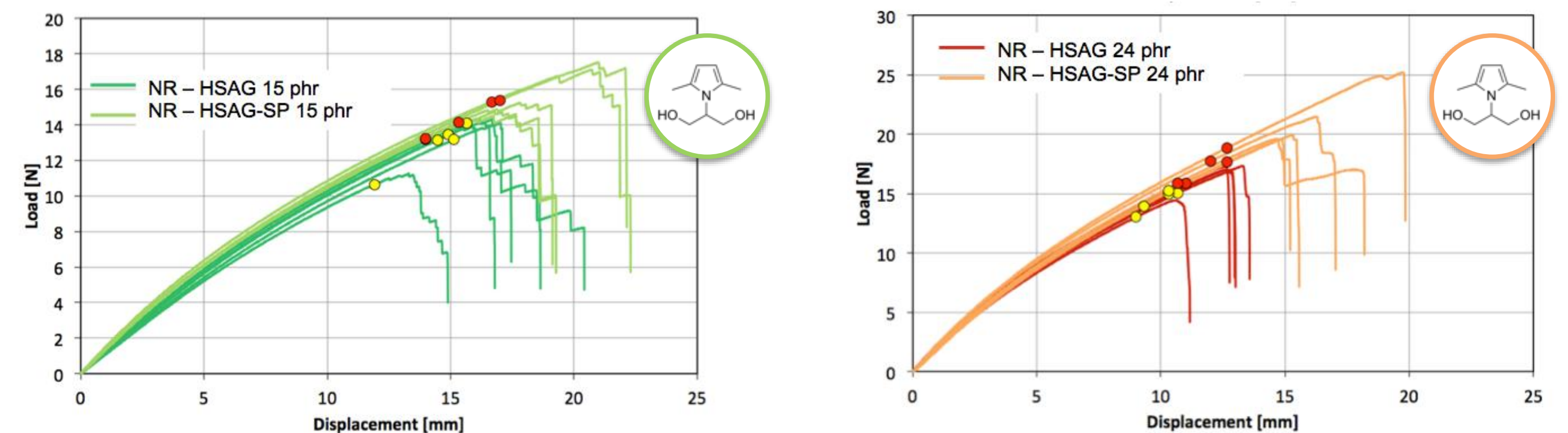
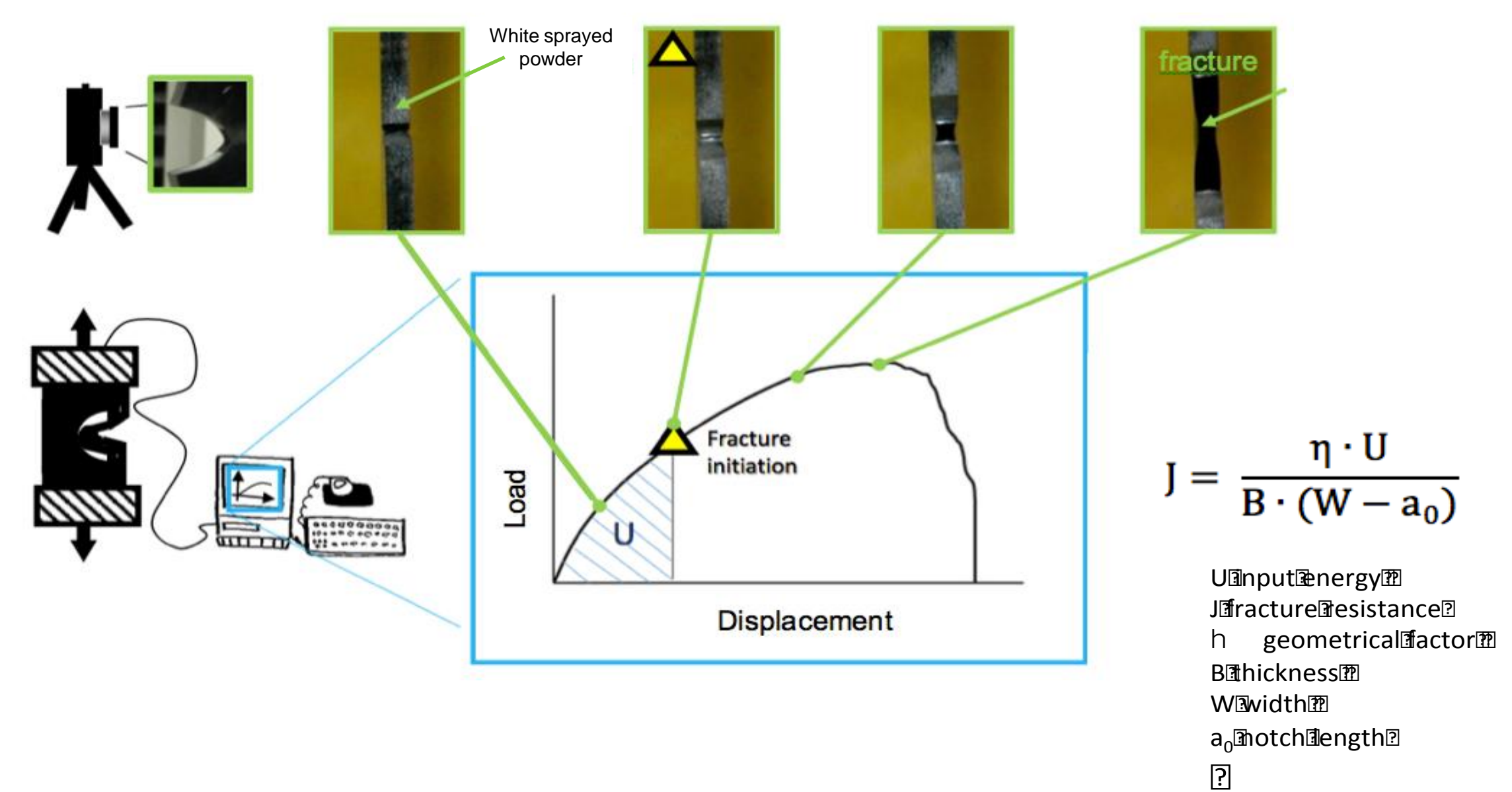


Parameters	NR	HSAG 5.2 phr	HSAG 15 phr	HSAG 24 phr	HSAG-SP 5.2 phr	HSAG-SP 15 phr	HSAG-SP 24 phr
σ_{50} (MPa)	0.57	0.56	0.69	1.05	0.54	0.8	1.03
σ_{100} (MPa)	0.82	0.84	1.15	1.92	0.8	1.31	1.9
σ_B (MPa)	24.47	13.6	21.39	24.31	19.57	23.13	25.35
ϵ_B (%)	760.02	561.2	516.53	468.69	633.69	536.07	493.01

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 resistance⁴:



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

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 of strain-induced crystallization⁵; therefore SP seems to favour this phenomenon.

TEM analyses

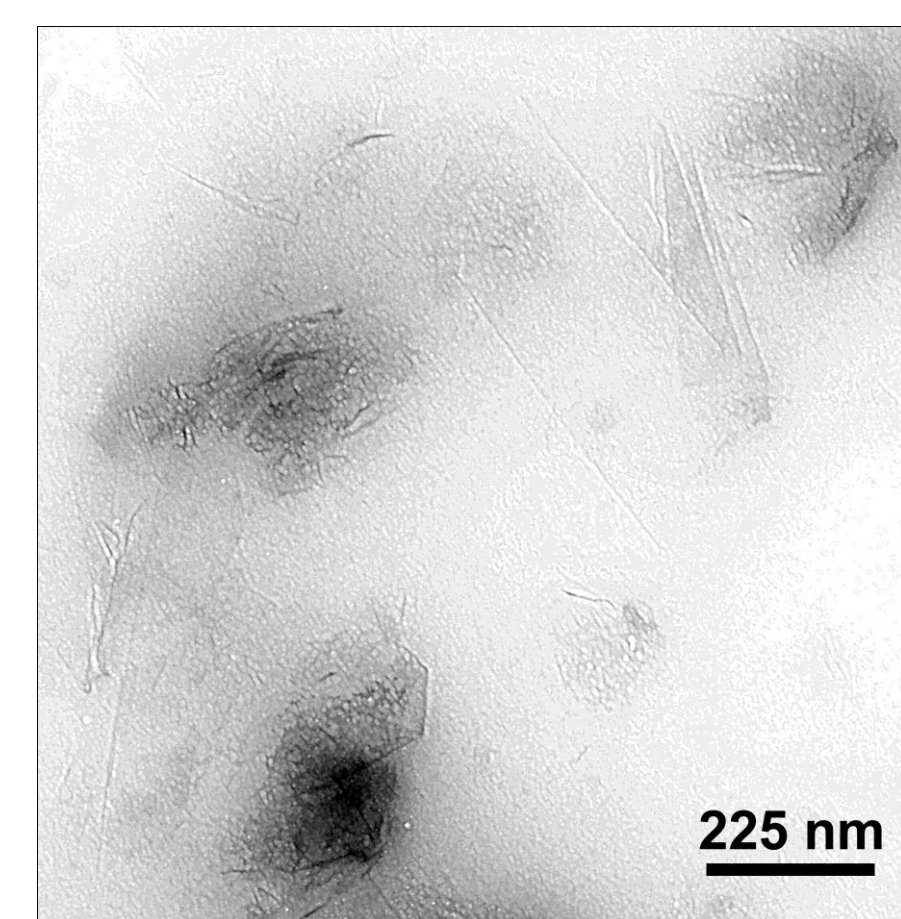


Figure 3. TEM image of a 24 phr HSAG-SP compound. Bundles of few graphene layers and also a few isolated layers are visible, suggesting a good dispersion in the matrix. Furthermore single agglomerates show a high level of disorder which suggests a reduced tendency towards aggregation.

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

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