CUSTOMISED NANOCOMPOSITES BASED ON RUBBER MATRICES FOR HIGH DEMAND APPLICATIONS.

CLAUDIO FERNANDEZ, LUIS MARTINEZ DE MORENTIN, MIGUEL SAINZ
FUNDACIÓN L'UREDERRA
Area Industrial Perguita c/A nº 1 Los Arcos 31210 NAVARRA (SPAIN)
claudio.fernadez@lurederra.es

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Fundación L'Urederra, DPTO. De Investigación y Desarrollo Tecnológico, Area Industrial Perguita c/A nº 1, Los Arcos (Navarra), SPAIN

Università Degli Studi di Milano, Dipartimento di Chimica Organica e Industriale, Via Golgi 19, I -20133 Milano, ITALY
Institute for Engineering of Polymer Materials and Dyes Division of Elastomers and Rubber Technology, Piastow, POLAND
Smithers Rapra Technology Limited, Shawbury Shrewsbury, Shropshire SY4 4NR, UNITED KINGDOM.
Laviosa Chimica Mineraria Spa. Via Leonardo Da Vinci, Livorno, ITALY.
Plasma & Ceramic Technologies Ltd, LTD 34 Miera Str LV-2169 SALASPILS-1, LATVIA

I. INTRODUCTION.

The NANORUB project aims to improve the knowledge and understanding of nanofillers and their application to rubber products facilitating the development of high performance formulations. The project's aim is to demonstrate the opportunity of providing step changes in the performance of elastomeric materials through the incorporation of mineral nanofillers. Target property improvements include notable increase in modulus and tensile strength, gas/liquid transmission rates reduced, and tear strength improved by 20 %. One of the other main goals of this project is to avoid the effect on the vulcanisation processes of commercial nanofillers.

II. EXPERIMENTAL.

1 Organic modification of Montmorillonite

Appropriate amount of montmorillonite is dispersed under vigorous stirring → Exfoliant addition →  → Coupling addition → Reaction mixture was continuously stirred at the appropriate temperature → Drying and filtering process → Final powder. Organically modified montmorillonite completely exfoliated and impregnated with coupling agent. 

2 Production of specific composites

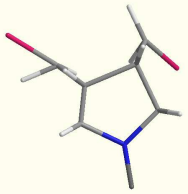

Organic montmorillonite → Latex addition/ Mixing process → 
Nanorubber masterbatches → Formulation/ Addition of additives → Nanorubber material

3 Production/testing of nanorubber prototypes

Nanorubber material → Testing: Mechanical properties, → Manufacture of prototype parts previously selected by end-user → Moulded parts; Conveyor belts; Rubber bearings

III. ORGANIC MODIFIERS (Exfoliants).

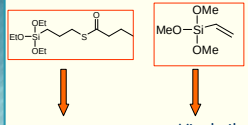
•Polvmeric ammonium salts



• Low MW polymerizable ammonium salts

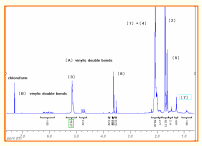
IV. COUPLING AGENTS.

•Purpose-designed silanes

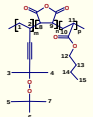


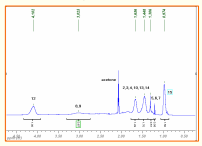
Mercapto functional silane — Vinyl silane

•Functionalised rubber


H-NMRspectrum

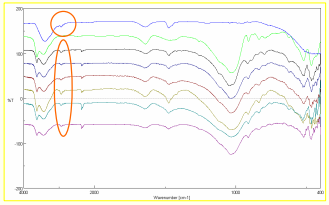
•Reactive Oligomer




H-NMR spectrum

V. RESULTS.

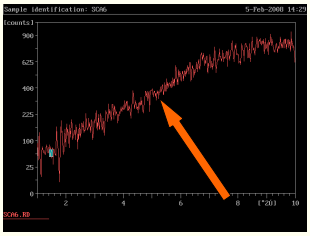
IR spectra of modified nanoclays



Pristine nanoclay (patron)

Diagnostic peaks marked on the spectra (aliphatic groups) confirm the presence of the modifier in the samples.

XRD Analysis



XRD spectrum of modified nanoclay with 15% of polymeric ammonium salt.

NO PEAK!!

COMPLETELY EXFOLIATED STRUCTURE

Mechanical properties of nanorubber material

PROPERTIES	REFERENCE VALUE	TARGET IMPROVEMENT VALUE	REFERENCE FORMULATION MONTMORILLONITE
Hardness *(Shore A)* s. ASTM D 2240	60	60	61-61,5
Tensile strength *(MPa)* s. ASTM D 412	20,6	22-23	21,9
Elongation at break *(%)* s. ASTM D 412	494,7	440-460	531,1
Abrasion resistance *(mm3)* s. ASTM D 2228	163	114-130	139,7
Tear strength *(N/mm)* s. ASTM D 624 (DIEC)	41,5	45,6-49,8	46,5

Nanorubber prototype

Picture below shows one of the parts manufactured by one end-user organisation with the formulation reinforced with organic nanoclay.

VI. CONCLUSIONS

• A new procedure for the organic modification (exfoliation) and impregnation with coupling agents of new nanofillers (montmorillonite) has been developed. New organic treatment achieves the complete exfoliation of the montmorillonite.

• New organic nanoclay developed has been successfully tested into rubber compound increasing mechanical properties and keeping processing conditions, rheological properties and vulcanisation rates.

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WWW.LUREDERRA.ES
lurederra@lurederra.es