

## Abstract

The objective of this work is to enhance the thermal and tensile properties (tensile strength, elongation at break and modulus) of natural rubber (NR) by converting it into new nanocomposite natural rubber (nano-NR). Montmorillonite (MMT) modification with fatty amides (FAs) as surfactants vegetarian organic was used as an additive to NR to improve its characteristics. For the sake of comparison nano-NR was produced using the conventional procedure of Dodecyl ammonium chloride (DDA) as surfactants petroleum organic (DDA-MMT). 1 to 5 part per hundred rubber (phr) of FAs-MMT and DDA-MMT was used.

The nano-NR was synthesized by melt-blending of the FAs-MMT and NR. Fatty amides (FAs), which were synthesized from palm oil, have been used as organic surfactant and the clay modification layer distance increases from 1.21 to 2.65 nm. The nano-NR was then characterized using X-ray diffraction (XRD), transmission electron microscopy (TEM), thermogravimetric analysis (TGA) and tensile properties measurement.

The XRD, TEM and TGA results confirmed the production of nano-NR, they show higher thermal stability and observed that the results of a device tensile reinforcement of tensile properties in comparison with those of the pure NR, micro-NR and nano-NR based on DDA. The optimum phr for FAs-MMT and DDA-MMT is found to be 3 and 2 respectively. The use of FAs reduced the dependence on petroleum-based surfactants. In addition to renewable resources, this nano-NR are considered as environmentally friendly. The use FAs-MMT with synthetic rubber is recommended for further research.

## الخلاصة

الغرض من هذا العمل هو تحسين الخواص الحرارية والشدية (مقاومة الشد، الأستطالة عند الكسر ومعيار المرونة) للمطاط الطبيعي (NR) بواسطة تحويل المطاط الطبيعي الى مركبات نانوية جديدة (nano-NR) بواسطة اضافة المونتموريلونيت (MMT) المحور بالأמידات الدهنية (FAS) كمروغات عضوية نباتية تستخدم بأضافتها الى المطاط الطبيعي للتطوير كما يبين التشخيص . لأجل مقارنة المركب النانوي المنتج يستخدم منتج تقليدي دوديسيل كلوريد الأمونيوم كمروغ عضوي بترولي ( DDA ) يضاف الى المونتموريلونيت لتحويله الى (DDA-MMT) ، ونسبة اضافة MMT المحور بالمروغ العضوي النباتي والبترولي الى المطاط الطبيعي من 1 الى 5 جزء لكل مئة جزء مطاط (phr) للأستخدام.

المطاط الطبيعي النانوي يحضر بواسطة مزج منصهر المطاط مع MMT المحور بالأמידات الدهنية (FAS) التي تحضر من زيت النخيل لتستخدم كمروغ وتزيد المسافة بين طبقات MMT المحور من 1.21nm الى 2.65nm . تشخص المركبات النانوية الناتجة بأستخدام حيود الأشعة السينية (XRD) ، الأنتقال الألكتروني الميكروسكوبي (TEM) ، التحليل الحراري الوزني (TGA) وقياس الخواص الشدية .

أن نتائج XRD، TEM و TGA تؤكد أن المنتج هو مركب نانوي ويبين أن له إستقرارية حرارية عالية ولوحظ من نتائج جهاز الشد تقوية في الخواص الشدية عند مقارنتها مع المطاط الطبيعي النقي والمطاط الطبيعي ذو المكون التقليدي والمطاط الطبيعي النانوي المعتمد على المروغ العضوي البترولي (DDA). أن أفضل نسبة phr مضافة من MMT المحور بمروغ نباتي و بترولي تبين بأنه كان 3 و 2 على التوالي، أن أستخدام FAS يختزل الأعتدال على المروغات البترولية وبأستخدامها نحصل على مركبات نانوية صديقة للبيئة. لمزيد من البحث نوصي بأستخدام FAS-MMT مع المطاط الصناعي .

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## List of Abbreviations

Symbol	Description
NR	Natural Rubber
Nano-NR	Nanocomposites natural rubber
Micro-NR	Microcomposites natural rubber
MMT(Na-MMT)	Montmorillonite ( Sodium -montmorillonite)
TOT	Tetrahedral- Octahedral- Tetrahedral
FAs	Fatty amides
DDA	Dodecyl ammonium chloride
ODA	Octadecyl amine ammonium chloride
FH	Fatty Hydrazide
FAs-MMT	Organoclay (Fatty amides- montmorillonite)
DDA-MMT	Organoclay (Dodecyl ammonium chloride - montmorillonite)
XRD	X-ray diffraction
TGA	Thermogravimetric analysis
TEM	Transmission electron microscopy
T <sub>m</sub>	Melting point
T <sub>g</sub>	Glass transition point
Phr	Part per hundred rubber

PLS	Polymer layered silicate
PEO	Polyethylene oxide
PVA	Polyvinyl alcohol
SAXD	Small angle X-ray diffraction
WAXD	Wide angle X-ray diffraction
MPa	Megapascals
Gpa	Gigapascals
MRB	Malaysian rubber board
CCD	Charge-coupled device
EFTEM	Energy Filtering Transmission Electron Microscop
CEC	Cation exchange capacity
Rpm	Revolution per minute
TS	Tensile strength
$L_0$	Is the original, unstretched length of the specimen
L	Is the stretched length of the specimen
UTS	Ultimate tensile strength
NR/2 Phr Na-MMT	The blending of 98 % natural rubber with 2% montmorillonite ( Sodium- montmorillonite)
NR/3Phr FAs-MMT	The blending of 97% natural rubber with 3% fatty amides- montmorillonite
NR/2PhrDDA-MMT	The blending of 98 % natural rubber with 2% Dodecyl ammonium chloride- montmorillonite