

# الآية

قال تعالى:

" قل هل يستوي الذين يعلمون و الذين لا يعلمون إنما يتذكر اولو الألباب "

صدق الله العظيم

سورة الزمر الآية (9)

## Dedication

*The Author dedicates this effort*

*To my well – beloved mother and father*

*To brothers, sisters and*

*Extended family*

*Precious and beautiful friends and colleagues...*

*To every body who contributed in this work directly or*

*indirectly*

*May Allah bless them all*

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## ABSTRACT

For many years, polypropylene (PP) has been very successfully used for film blown, injection molded, and extrusion applications. This work aimed to study the effect of linear low density polyethylene (LLDPE), talc and calcium carbonates on mechanical, thermal and rheological properties of local homopolymer polypropylene (PP) for injection molded application. In, five formulations of PP and LLDPE viz. 90/10, 80/20, 70/30, 60/40 and 50/50 in ratio of weight percentage were prepared for injection moulding machine. PP/LLDPE (70/30) blend was selected and further investigated using different four fractions of talc and calcium carbonate. The resulted samples were subjected to mechanical properties tests such as flexural modulus, impact resistance and hardness. The thermal properties such as heat deflection temperature (HDT) were evaluated. The rheological properties such as melt flow index (MFI) and melt density were recorded, in addition, density test have been determined.

The results showed improvement on the mechanical, thermal and rheological properties. It is then concluded that the optimum compounds of PP/LLDPE blends provided good mechanical, thermal properties and a moderate rheological properties was 70/30. However incorporated talc and calcium carbonate led to increase the hardness, MFI and melt density while then decreased the impact resistance of PP/LLDPE blend. It was realized that increase of talc and calcium carbonate content into PP/LLDPE blends increase the density. Taking this into consideration, thus the optimum compounds provided good balance of cost and performance (mechanical, rheological properties and density) of PP/LLDPE/Talc/CaCO<sub>3</sub> was (42/18/20/20) in ratio of weight percentage respectively.

## المستخلص

تستخدم مادة البولي بروبيلين في الكثير من التطبيقات منها نفخ الأفلام والتشكيل بالحقن والبتق. الهدف من هذا البحث دراسة تقييم وتحسين الخصائص الميكانيكية، الحرارية والريولوجية لمادة البولي بروبيلين المنتج محلياً PP<sub>KPC-114</sub> المستخدم في تطبيقات التشكيل بالحقن عن طريق إضافة مادة البولي إيثيلين منخفض الكثافة الخطي والتلك وكربونات الكالسيوم. تم تجهيز 5 خلطات من مزيج البولي بروبيلين مع البولي أثلين الخطي منخفض الكثافة بنسب وزنيه هي 90/10 ، 80/20 ، 70/30 ، 60/40 و 50/50. تم اختيار المزيج 70/30 ليضاف له أربعة نسب مختلفة من مادتي التلك وكربونات الكالسيوم كمواد مالئة. تم إجراء اختبارات ميكانيكية مثل اختبار الكسر، والصدم والصلادة واختبار حراري هو اختبار درجة حرارة الانحراف الحراري . اختبارات ريولوجية مثل اختبار معامل إنسياب المصهور وكثافة المصهور. كما تم أيضاً إجراء اختبار الكثافة. حيث أظهرت تحسن واضح في الخصائص الميكانيكية، الحرارية والريولوجية لمادة البولي بروبيلين عند مزجه مع البولي إيثلين منخفض الكثافة الخطي وأن افضل مزيج يعطي خصائص ميكانيكية وحرارية ممتازة وخصائص ريولوجية معتدلة هو 70/30.

أضافة المواد المالئة (التلك وكربونات الكالسيوم) للمزيج 70/30 أدى إلى زيادة الصلادة، معامل إنسياب المصهور وكثافة المصهور وإلى إنقاص مقاومة الصدم. النتائج أيضاً اظهرت ان زيادة المواد المالئة تؤدي إلى زيادة الكثافة . توصل البحث إلى ان افضل مزيج للبولي بروبيلين مع البولي إيثلين منخفض الكثافة هو 70/30 وان افضل نسبة للمواد المالئة مع المزيج لتعطي أفضل موازنة بين التكلفة و الخصائص (ميكانيكية، ريولوجية وكثافة) هو (بولي بروبيلين/بولي إيثلين منخفض الكثافة/التلك/كربونات الكالسيوم) هي على التوالي (20/20/18/42) .

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## List of Abbreviation

<b>Abbreviation</b>	<b>Meaning</b>
PP	Polypropylene
VOCs	Volatile organic compounds
KPC	Khartoum Petrochemical Company-Sudan
KPC 113	KPC polypropylene Extrusion grade
KPC 114	KPC polypropylene injection moulding grade
HPP	Homopolymer Polypropylene
RCP	Random copolymer
ICP	Impact copolymer
ASTM	American Society for Testing and Materials
T <sub>m</sub>	Melting point temperature
EPDM	Ethylene propylene diene monomer
ABS	Acrylonitrile butadiene styrene
LDPE	Low density polyethylene
HDPE	High density polyethylene
LLDPE	Linear low density polyethylene
VLDPE	Very low density polyethylene
EVA	Ethylene vinyl acetate
mLLDPE	Metallocene linear low density polyethylene
ABS	Acrylonitrile butadiene styrene ,
RM	Rockwell M
RR	Rockwell R
HIPS	High impact polystyrene
SD	Shore Durometer
t p a	Ton per annul
MAPP	Maleic anhydride grafted polypropylene

AMPTES	Aminopropyltriethoxy
SF	Sisal fiber
RPP	Reinforced recycled polypropylene
TGA	Thermogravimetric analysis and heat
DSC	Differential scanning calorimeter
HDT	Heat deflection temperature
SEM	scanning electron micrograph
TREF	Temperature rising elution fractionation
TPO	Thermoplastic polyolefin
MFR	Melt flow rate
SHI	Shear thinning index
VA	Vinyl acetate
HDT	Heat deflection temperature
MFI	Melt flow index
ISO	International Organization for Standardization
PVC	Poly vinyl chloride