Tensile Behaviour and Fracture Characteristics of Polydimethylsiloxane (PDMS) filled Silica Composites

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Abstract
The focus of this study is to investigate the mechanical properties and fracture behaviour of polydimethylsiloxane filled crystalline silica composites (PDMS/CS) via tensile test. The PDMS/CS composites were fabricated by using casting method and cured at room temperature for 24 hours. Crystalline silica were filled into PDMS at composition of 2, 6, 10 wt%. The tensile properties of PDMS/2wt%CS showed that the tensile stress was improved by 4.3%. Fracture behaviour of the tested PDMS/CS composites were characterized using Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) which used to determine the characteristic of fracture surface. Observation via SEM and AFM showed that the increment of filler in PDMS increased the tendency of the filler to be agglomerated and increase the surface roughness of PDMS/CS composites. Thus, this concludes that the agglomeration of fillers effect to the overall mechanical strength of the PDMS/CS is insignificant. However, the additions of fillers were proven to improve the strength of the composites.

Introduction
Particulate polymer composites are also called as filled polymers due to the usage of filler material in form of particle. Particulate composites consist of heterogeneous systems which imply that, the filler and polymers flow and disperse together during processing [1].

Particulate polymer composites offer interesting mechanical, physical and rheological properties resulting from polymer matrix and filler dispersed phase interaction. Polymer matrix and filler have to be prepared through mixing process which requires specific equipment in order to achieve uniform dispersion of fillers in the polymer matrix [2].

The significance of filler addition on polymer is to modify latter properties, either physical properties for conductivity or mechanical properties in exampie strength, modulus, stiffness, *etc* or rheological properties such as viscoelasticity or viscosity or density [3].

This study focuses on improving PDMS tensile properties by assistance of silica filler and identifies tensile fracture behaviour. PDMS or so called as silicone rubber will be filled with crystalline silica. Casting method were used to fabricate the composites Several previous studies have shown that filling PDMS with reinforced filler will enhanced PDMS in terms of its physical, mechanical and chemical properties [4].

Experimental
Composites Fabrication
Casting method used was closed molding type in order to fabricate the PDMS/CS composites. The fabricated sample dimension is 300x300x3mm.

Test method

XRD

The purpose of this analysis is to characterize silica structure. XRD Bruker D8 Advance was used to conduct the analysis.

Tensile

Tensile properties were determined as per ASTM D412. Universal Testing Machine (UTM), Shimadzu AG-1 10kn was used to conduct the testing.

Fracture Surface Analysis

Tensile fracture surface were analyzed by using SEM and AFM. JEOL JSM-6380LA was used to conduct SEM and AFM conducted via Park Systems XE100.

Result and Discussion

EDS Analysis

EDS analysis revealed the presence of SiO2 in the fabricated PDMS filled silica panel.

Tensile Properties

Tensile properties of PDMS/CS composites were conducted as per ASTM D412. Four types of materials were fabricated were; PDMS/0WT%CS, PDMS/2WT%CS, PDMS/6WT%CS, and PDMS/10WT%CS. The results show depicted that the tensile strength of PDMS at 4.64MPa had increased to 4.80 MPa with addition of filler in PDMS/2wt%CS. Fig. 1 shows the tensile strength of PDMS composites.

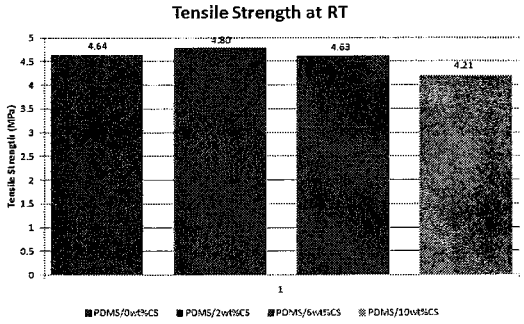

Fig. 1: PDMS composites tensile strength

Fracture Characteristics

Fracture analysis conducted through SEM and AFM shows that the main causes of crack propagation were filler agglomeration and voids. The voids and agglomerations were found to increase with the content of fillers. However the good bonding between PDMS and silica were achieved at 2wt% crystalline silica addition.

Conclusions

PDMS filled with crystalline silica were fabricated successfully. PDMS/2wt%CS had shows good matrix-filler bonding through SEM and AFM observations. Furthermore, crystalline silica effectively plays its role as filler by increased 4.3% of the PDMS tensile strength with 2wt% addition.

References

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