CERAMIC SCRAP LOADING IN THE UNSATURATED POLYESTER RESIN

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Abstract

This work tried to load ceramic scrap into the unsaturated polyester resin (UPR) as the filler. The ceramic scrap (hard porcelain) was ground into the form of powder. The ceramic scrap powder (CSP) was loaded into the UPR in various contents between 10 to 100 phr. The effects of ceramic scrap content on both physical and mechanical properties of the tested specimens were investigated.

The results under the test conditions suggested that the CSP acted as the extended filler when loaded into the UPR. The effects of loaded into the UPR were increasing of density, flexural modulus and hardness. However, the presence of CSP leaded to decrease the flexural strength. The advantage of CSP addition into the UPR that could be observed from this research was abrasion resistance increasing

1 Introduction

The Pollution Control Department (PCD) under the Ministry of Natural Resources and Environment reports that there are 12.3 million tons of industrial garbage including papers, glasses, plastics, irons, aluminums and rubbers. However, only 49% (6 million tons) could be recycled [1]. International legislation and increasing environmental concerns have resulted in significant pressure to reduce and / or recycle industrial garbage or scrap. There are numerous ceramics product factory in Thailand. The ceramic production process also produces the plenty of ceramic scraps, which have to consume the cost for dispose of them. This research purposed to seek the alternative way to increasing the value of the ceramic scrap. This study tried to load ceramic scrap into the unsaturated polyester resin (UPR) as the filler. The effects of ceramic scrap content on both physical and mechanical properties of the tested specimens were investigated.

2 Experimental

2.1 Materials

The ceramic scrap (hard porcelain) was ground into the form of powder. The ceramic scrap powder (CSP), which had average particle dimension size 13.07 µm, was loaded into the UPR in various contents between 10 to 100 phr. The 0.5 % wt of accelerator was cobalt nephthalate and the 0.5 % wt of catalyst was methyl ethyl ketone peroxide were added in the resin.

2.2 Sample Preparation and Testing Methods

The tested specimens were produced by casting process. The smooth surface mirrors were used as the molds and the PVC gaskets were used for control the specimens size and thickness. The tested specimens were cured at the room temperature. The density was tested according to ASTM D 792 procedure. The flexural modulus and flexural strength were tested by the universal testing machine depended on ASTM D 790 standard. The shore durometer was used for hardness determination according to ASTM 2240. The abrasion resistance was tested according to ASTM D 1044 procedure. The abrasion resistance was reported in the term of weight loss value after abraded the tested specimen on the abrasive tester.

3 Results and Discussion

The results under the test conditions suggested that the density of the tested specimen was increased when the CSP content increased as shows in Fig.1. The density of the unloaded CSP specimen was 1.14 g/cm^3 while the density of the 100 phr loaded CSP specimen was 1.50 g/cm^3. Fig.2 shows the relationship between the flxtural modulus and CSP contents. It was found that the flexural modulus increased with the CSP content increasing because of the higher rigidity of the CSP than the UPR thus when loaded the CSP into the UPR could be leaded to increase the flexural modulus of the system [2].

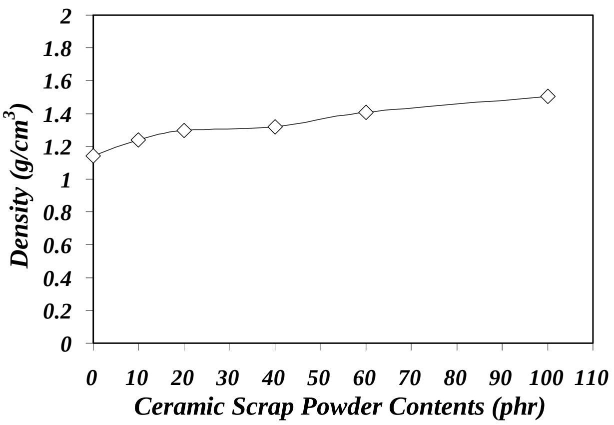

Fig. 1. Relationship between density and CSP content of the specimens

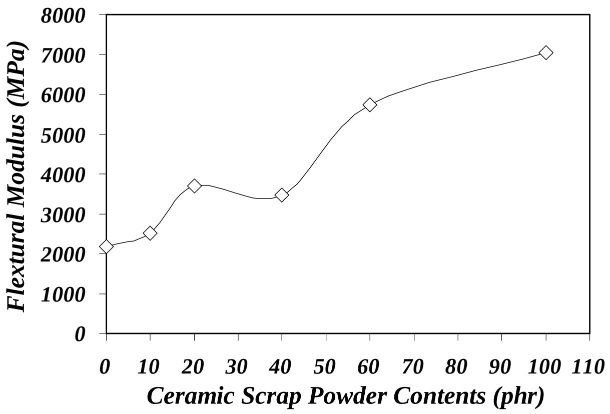

Fig. 2. Relationship between flexural modulus and CSP content of the specimens

The effects of CSP contents on the flextural strength shows in Fig.3. The flexural strength of the tested specimen were decreased when the CSP contents were increased thus there are no reinforcing interaction between the UPR and the CSP, these result was opposite to the previous work which study about the reinforcing effect of the filler [2,3]. The hardness of the unloaded CSP specimen was 82.9 shore D while the hardness of the 100 phr loaded CSP specimen was 88.4 shore D as illustrates in Fig.4. The presence of CSP slightly increased in the hardness because the CSP had higher hardness than the UPR . Fig.5. shows the scanning electron micrographs at magnification of 500 x of the unloaded CSP specimen, the 20 phr loaded CSP specimen and the 100 phr loaded CSP specimen. It colud be observed from Fig.5 that the CPS had the flake shape and The CSP particles were more dispersed into the surface of the resin when it was more loaded into the UPR. This result should be the cause of increasing hardness with the CSP increasing.

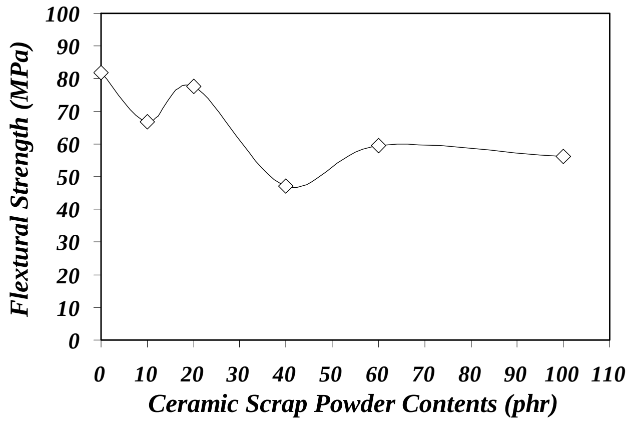

Fig. 3. Relationship between flexural strength and CSP content of the specimens

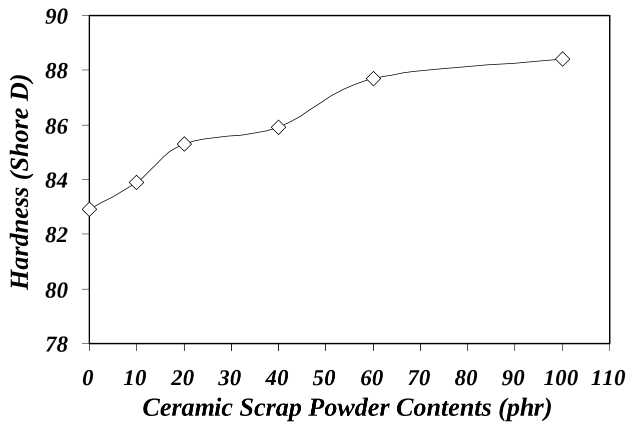

Fig. 4. Relationship between hardness and CSP content of the specimens

The other result of this reason should be indicated in the abrasive resistance test that was reported in the term of weight loss value as shows in Fig.6. The weight loss values after abraded the tested specimen on the abrasive tester were reduced when loaded the CSP between 10 to 40 phr. However, the weight loss values were increased when loaded the CSP between 60 to 100 phr. These results probably came from the increasing of the interfacial defect or debonding between the UPR and the CSP.

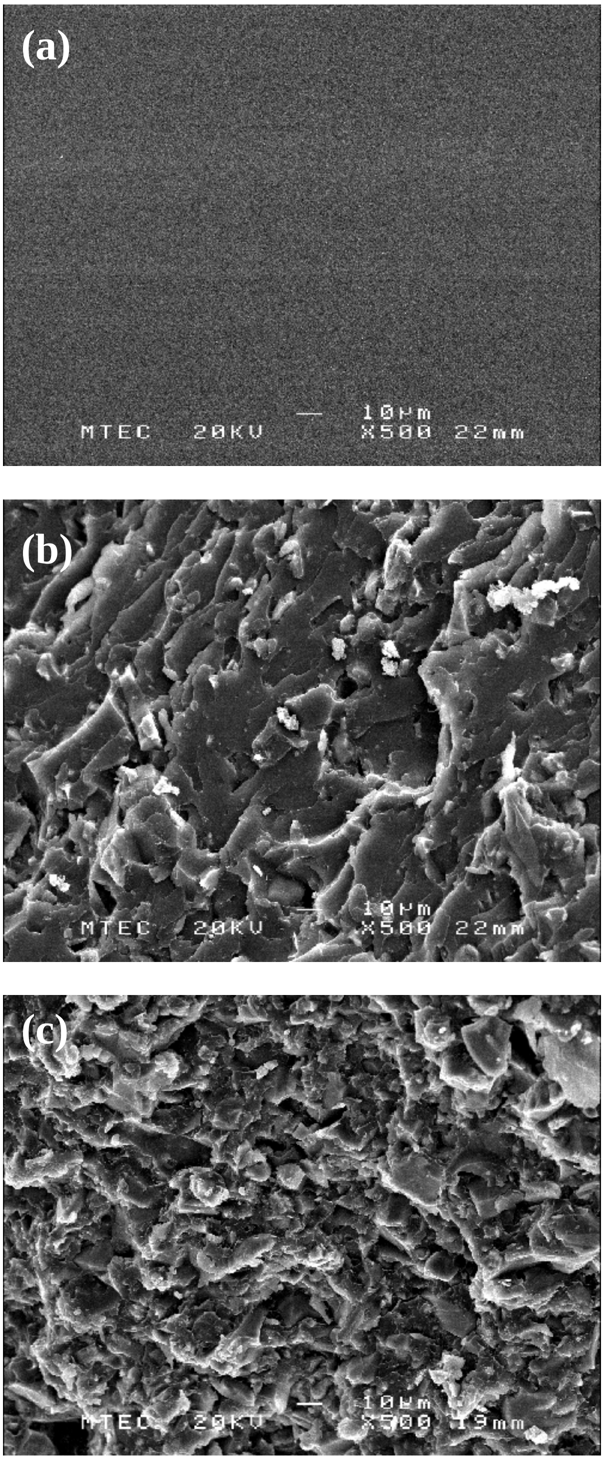

Fig. 5. Scanning Electron Micrograph;
(a) the unloaded CSP specimen
(b) the 20 phr loaded CSP specimen
(c) the 100 phr loaded CSP specimen

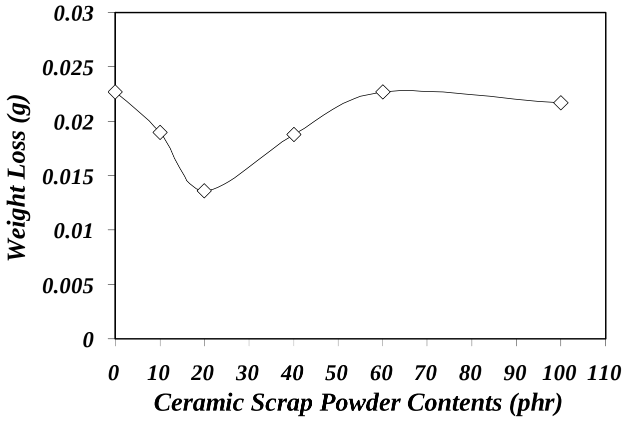

Fig. 6. Relationship between weight loss value and CSP content of the specimens

4. Conclusions

The CSP acted as the extended filler when loaded into the UPR. The effects of loaded into the UPR were increasing of density, flexural modulus and hardness. However, the presence of CSP leaded to decrease the flexural strength. The advantage of CSP addition into the UPR that could be observed from this research was abrasion resistance increasing.

Acknowledgement

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References

[1] Thailand Pollution Control Department. *“Overview of Thailand’s Pollution in year 2003”*. 2004.

[2] Sombatsompop N., Yotinwattanakumtorn C. and Thongpin C. “Influences of Types and Concentrations of Maleic Anhydride Grafted Polypropylene and Impact Modifiers on Mechanical Properties of PP/Wood Sawdust Composites”. *Journal of Applied Polymer Science*, Vol. 97, No. 2, pp 475-484, 2005.

[3] Sombatsompop N., Kantala C. and Wimolmala E. “Wood Sawdust Fibres as a Secondary Filler in Carbon Black Filled NR Vulcanizates”. *Polymers and Polymer Composites*, Vol. 14, No. 4, pp 331-347, 2006.