Orange peel waste as a reinforcing material for plasticised PVC

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Abstract Microparticles of orange peel waste have been added as a filler to plasticised PVC with different quantities (1,2,3) wt.% and measured the effect of these additives on the tensile strength of this polymer. The results of the Fourier transform infrared test (FTIR) showed that there are many effective groups in the structure orange peel microparticles that provide the best combination of the PVC and these particles. And according to the active groups found in orange peel, the tensile test results showed an improved tensile strength of plasticised PVC with 1 and 2 wt.% orange peel microparticles but decreased when the addition increased to 3 wt.%.

Keywords Orange peel, Plasticised PVC, Waste, Tensile strength, FTIR, Microparticles

1. INTRODUCTION

Agricultural waste is an accidental product of the production of food from various agricultural crops. Many of the supporters of these important economic materials tend to call them agricultural residues rather than agricultural residues. Agricultural residues vary in variety of agricultural crops and vary from one country to another according to the country's production of each agricultural crop [1-6]. These agricultural residues are considered renewable and environmentally friendly natural resources, which can be used in many fields for many benefits. Since ancient times and in many civilizations, these wastes have been used for many purposes that benefit the human society, so that these wastes have become a source of high value in the purpose used [7-12].

However, despite the many benefits of agricultural waste, it has caused serious environmental problems due to the lack of awareness of the value of these substances and the use of incorrect methods of disposal, and seek to find ways to reduce these problems to avoid the damage caused by them. One of the most important solutions proposed to reduce the damage caused by these agricultural wastes is to recycle them in order to reduce the impact of these wastes and their accumulation on the environment and to benefit from the production of useful products [13-19].

Recycling reduces waste disposal by landfill or burning, thus helping to reduce pollution and global warming. The process of recycling is very useful because it not only reduces the amount of household waste that is sent to landfills and incinerators but is also a means of sustainable development where we can help preserve the environment for future generations [10-12].

2. METHODOLOGY

2.1 Materials Used

PVC with 70% DOP supplied by BorsodChem Zrt., Hungary; and Orange peel as a waste material.

2.2 Materials Preparation

The first step was washing the orange peel and then drying it in a furnace at 50℃ for a period of 6 hours. Grind the dry orange peel to a fine powder with particle size (0.2 µm). Fine ground dry orange peel particles were added to the respectively. The batches were prepared from PVC with. Four batches were prepared by using the laboratory two roll mill type Schwabenthan (Fig.1), with forming conditions shown in Tab.1, and these batches included PVC with reinforcing fractions (1, 2, 3) wt% from orange peel particles In addition to pure PVC batch for comparison.

Samples were prepared at first step as sheets with 0.4-0.6 mm in thickness and then fabricated to the proper tensile strength shapes by using hydraulic press at 300 and 20 bar pressure and temperature 175°C. Tensile strength samples are cast according to (ASTM D638 -14).

Tab.1: Condition of rolling process

Temperature	170ºC
Time	5 min
Rolling speed	21 rpm, Front roller
	24 rpm, Back roller

Fig.1: Two roll mill type Schwabenthan (BorsodChem Zrt.)

2.3 Testes

Fourier transform infrared spectroscopy (FTIR): this test was done by using Bruker Tensor 27 FTIR spectroscope shown in Fig.2, to make detection of active compounds in orange peel powder.

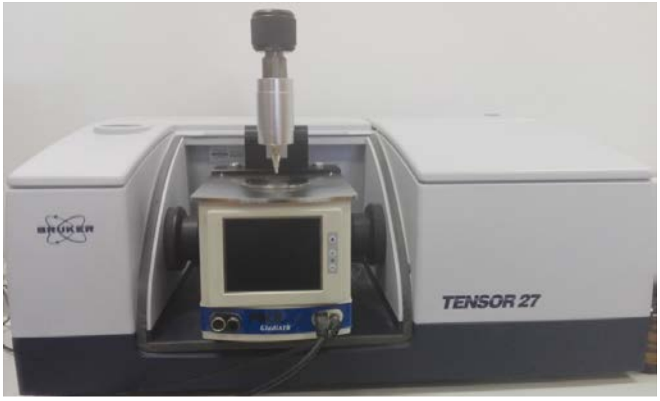

Fig.2: Bruker Tensor 27 FTIR spectroscope (Miskolc University)

Tensile Test: samples (Fig.3) were fabricated according to the ASTM D638-14. Instron 5560 instrument was used to To complete the tensile test shown in Fig.4.


Fig.3: Tensile test sample


Fig.4: Instron 5560 instrument (Miskolc University)

3. RESULTS AND DISCUSSIONS

Fig.5 represents Fourier transform infrared spectroscopy (FTIR). From this figure we can see there are many active groups as illustrated in Tab.2, which identifies the groups and numbers of wavelengths corresponding. Analysis of chemical conducted on the powder plant particles orange peel particles proved to fit on many of the groups active, orange peel consists of several chemical constituents like organic fats, pectins, lignin, reducing and non-reducing sugars all of which have many active functional groups (carboxyl, hydroxyl, aldehyde, etc.).

The presence of bounds double and ties triple and aromatic rings in powder plant the new system will improve the act bonding with matrix.

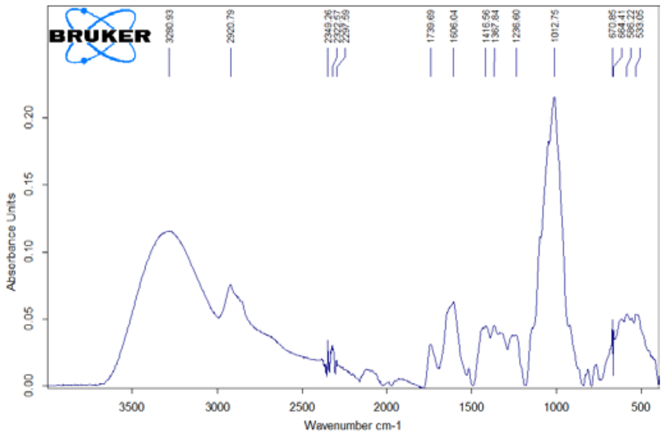

Fig. 5: Fourier transform infrared spectroscopy (FTIR) wavenumber vs. absorbance units for particles orange peels powder

Tab. 2: The active group and positive number

Positive Number	Active Group
(3280.93) cm-1	OH
(2920.79) cm-1	CH
(2349.26) cm-1	P-H
(1739.69) cm-1	C = O
(1606.04) cm-1	C = C
(1416.56) cm-1	-CH2
(1367.84) cm-1	-CH3
(1236.60) cm-1	CH-OH
(1012.75) cm-1	C–O-H or C–O-R
(670.85) cm-1	= CH
(664.41) cm-1	C-Br
(586.22) cm-1	O-N≡O
(533.05) cm-1	S – S

In Fig.6 shown the behavior of tensile strength for pure PVC without any addition and with added 1%, 2% and 3% from orange peel. It's clear from the Fig. the sample with 1% from orange peel it's the better because it bear high deformation before fracture than other samples. The sample with 3% orange peels it less tensile strength compare with other samples.

That mean the synthetic particles (1% orange peel) could impart reinforcement to the polymer matrix than other samples also the bonding between sample with 1% orange peel and polymer matrix strong (than in 2% and 3%).

Also tensile strength in samples 1% and 2% orange peel high (high strength against fracture) than pure PVC because orange peel after analysis by FTIR showed it contain chemical bonding such as (-OH, CH_2, CH_3, Si-O-Si, C=C, and Si=H) these compounds contain bounds double and ties triple cause aromatic rings in matrix of PVC than pure PVC.

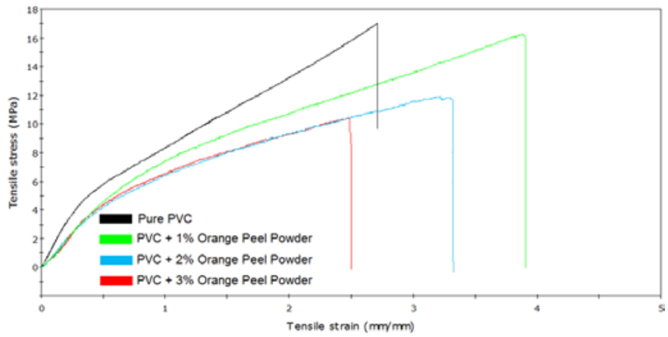

Fig.6 : Tensile strength of plasticised PVC befor and after orange peel additions

From all results of composite samples when increase content of orange peel particles decrease deformation and elongation at yield and at break in samples before fracture especially at 3%wt orange peel that's means poor bonding at high percentage with matrix, because at 3%wt orange peel forming stress concentration points with matrix and this point decrease the strength of the samples also this due to low wettability between particles and PVC.

4. CONCLUSIONS

Samples that reinforced with microparticles of orange peel waste have high strength against fracture than samples of pure PVC, and the optimum percentage was 1 wt.%. Effective groups in orange peel structure provides the best combination between PVC and microparticles.

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