CHARACTERIZATION OF A COMPOSITE POLYPROPYLENE /RESIDUAL CERAMIC

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Abstract

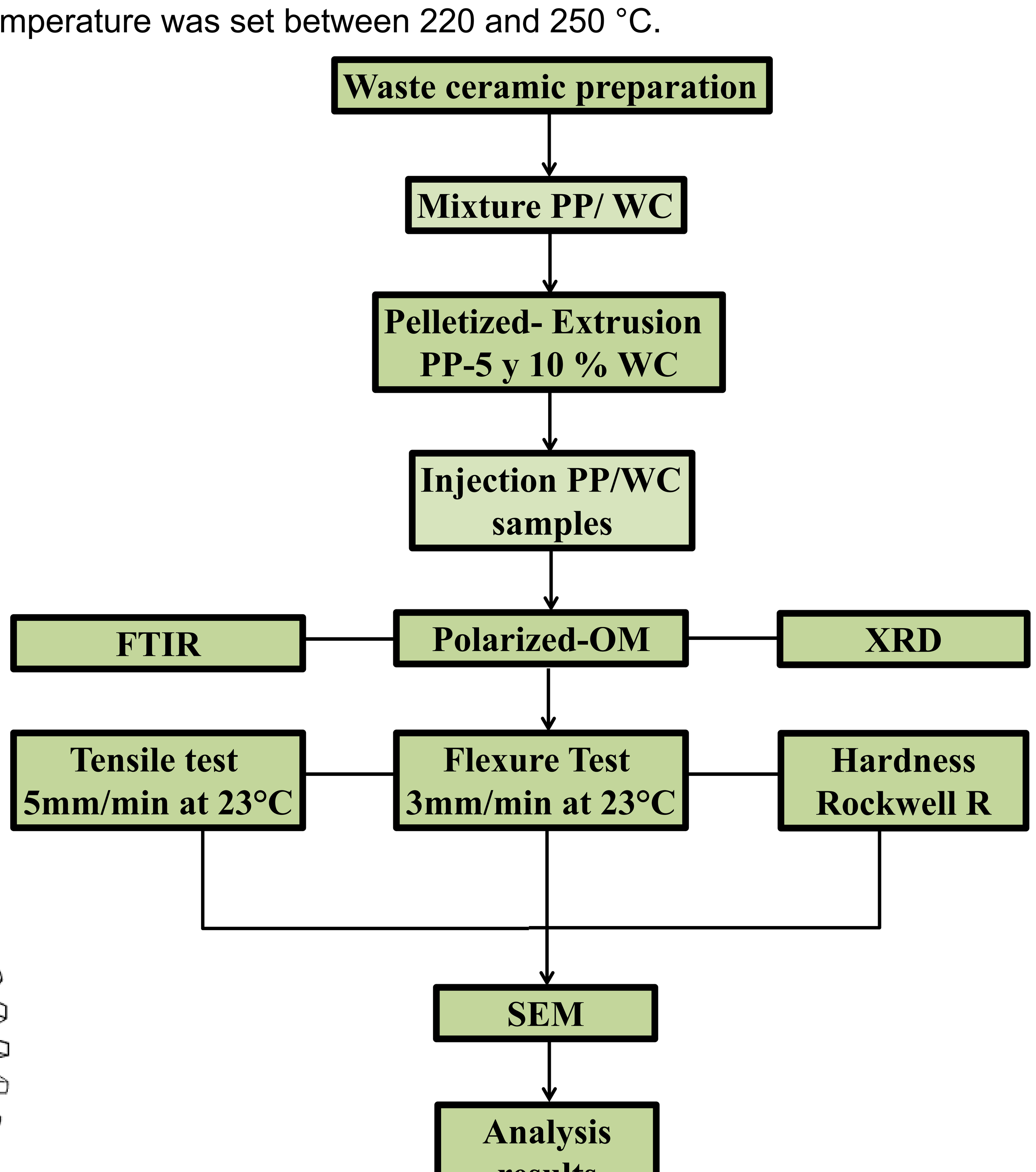
Composites are materials containing two or more distinct phases with an interface, the elements interact and modifying properties of virgin material. Control interface generates the interaction between the matrix and the particles, and the mechanical properties profile according to the structure of composito1. They are often added to a polymer matrix, which typically combine the advantages of its constituent phases generating improvements in their physical and chemical properties. Mullite is an excellent candidate as a reinforcing material for its properties, however, for practical applications needs to be reinforced with zirconia. Mullite is characterized by excellent mechanical properties such as: high modulus of rupture and compressive strength both cold and hot, chemical stability, thermal stability reflected by its low coefficient of thermal expansion. At the present work we produce a composite whose polymeric matrix is polypropylene added with a residual ceramic material investment casting process, Mullite - zirconia, and PPMA as compatibilizer. Mechanical tests were performed in composites varying the percentage of ceramic and compatibilizer, SEM tests were previously performed to determine the microstructure of the ceramic material

Introduction

Today's world is moving toward the development of sustainable materials that are both economically viable and environmentally friendly. In this aim, development of value-added materials from recycled industrial waste like polypropylene (PP) and fly ash (FA) is an interesting approach [1]. Polypropylene (PP) is one of the most widely used polymer matrix for thermoplastic composites, owing to its well balanced physical and mechanical properties, chemical inertness, light weight and ease of processing at a relatively low cost [2]. The physical properties and functionality of the semicrystalline polymer matrix such as PP largely depend on their microstructure and crystallinity [3, 4]. PP functionality can be modified by compounding it with various fillers such as particulates, fibers and other polymers [5]. The purpose this study of interaction of composite polypropylene matrix with adding a filler residual ceramic (RC) particles obtained from investment casting process, through complementary technique optical microscopy (OM) , analyze by infrared (FTIR), X-ray diffraction (XRD), scanning electronic microscopy (SEM), and determine their properties mechanical.

Experimental Procedure

The isoPP homopolymer was purchased from Indelpro Valtec Company (HS013). Density and melt flow rate at 230°C of PP were 0.9 g/cm^3. Ceramic waste (CW) was obtained of investment casting process. The composition of ceramic waste was determined 80 wt. % SiO_2-Al_2O_3 (mullita), 16 wt. % ZrO_2, 0.7 wt. % Fe_2O_3, 0.87 wt. % CaO, 0.5 wt. % MgO, 0.9 wt. % Na_2O, 0.5 wt. % K_2O, 0.5 wt. % MnO. The composition of ceramic waste was analyzed by means of mass spectrometric via liquid. The size of particles was obtained through the separation mechanical of the retained particles at 200 µm mesh. The size mean is 169 µm. Before mixing, the PP and CW were dried at 100°C for 2h. The extrusion process was used twin-screw and temperature of 250, 235, 230 and 200 °C. The screw speed was 150 rpm. The tensile and flexure test samples were prepared by injection process. Injection temperature was set between 220 and 250 °C.



Results

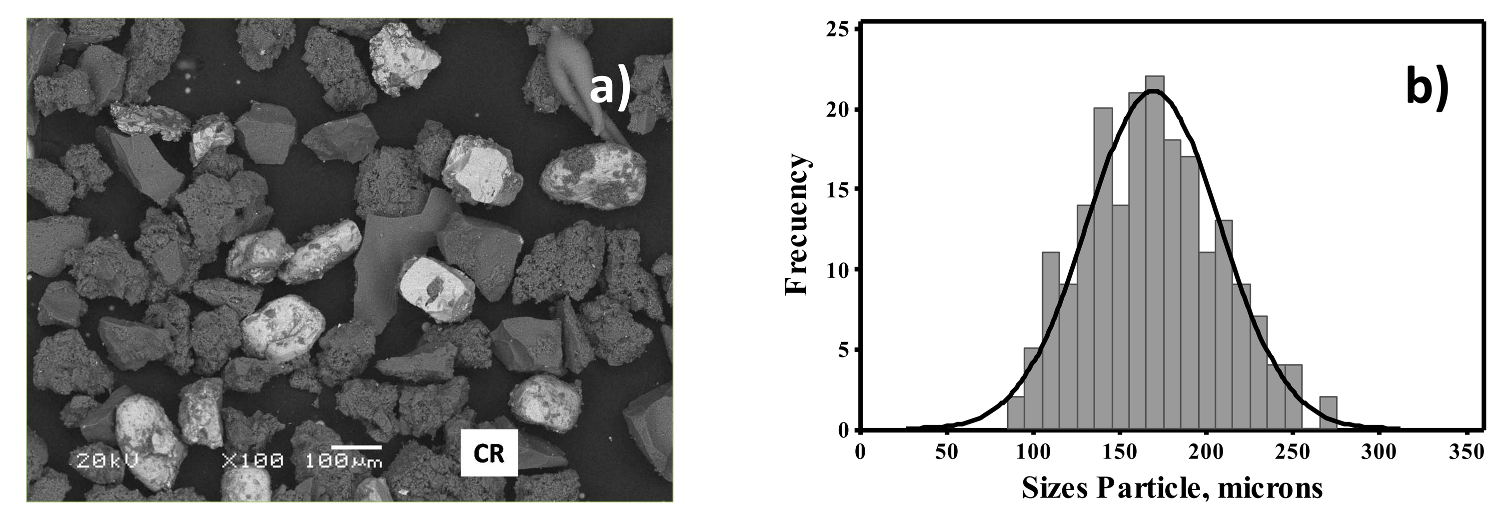


Fig. 1. SEM show a) the morphology and size of particle, b) measure of distribution of particles in the residual ceramic.

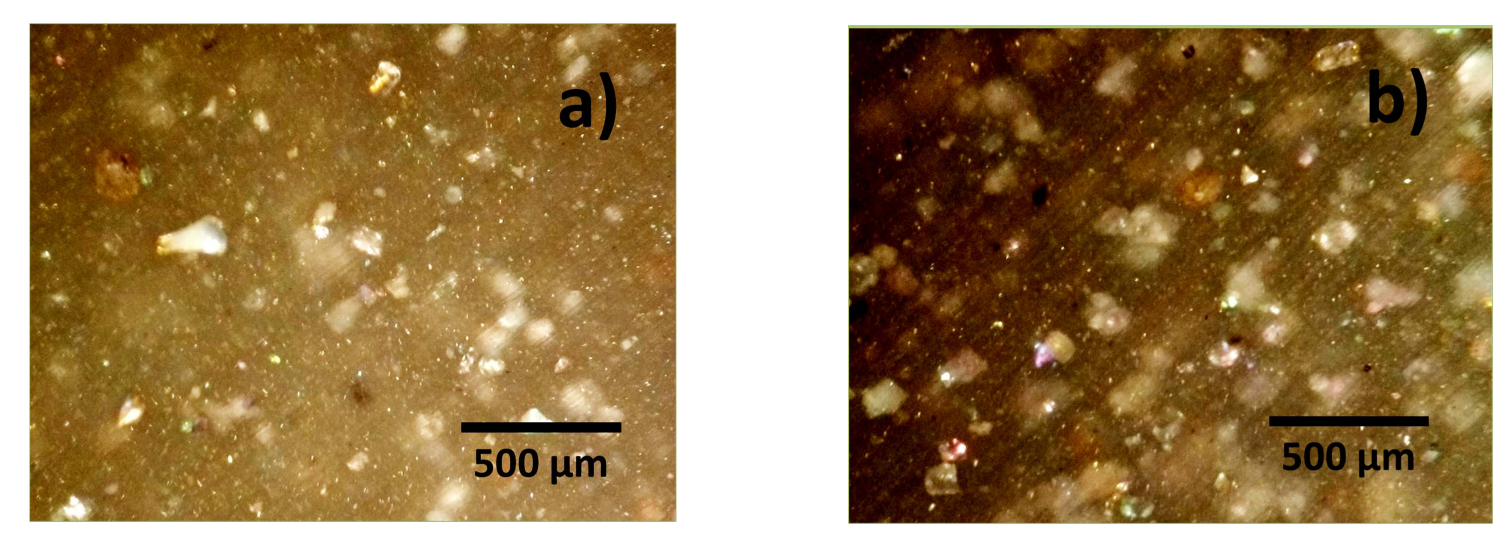


Fig. 2. Polarized light-OM show distribution of particles in the composite a) 5 % and 10 % wt. residual ceramic.

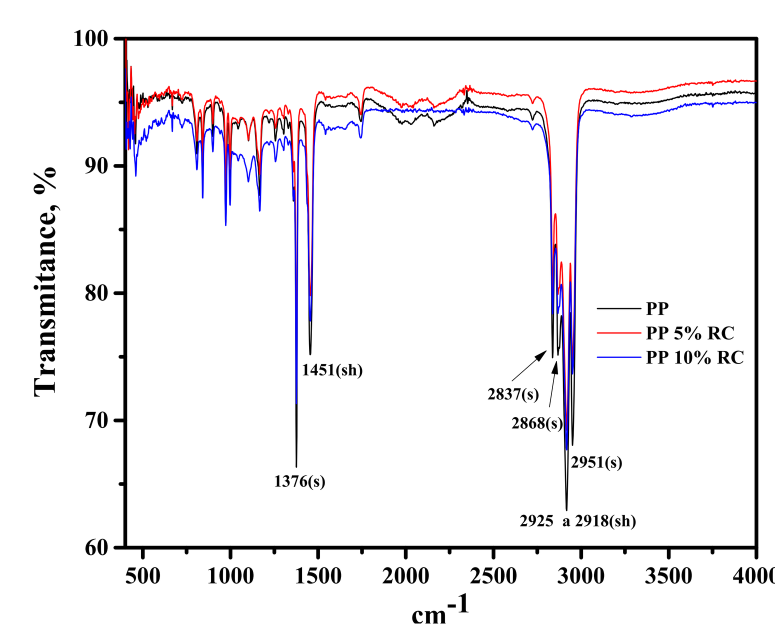


Fig. 3. FTIR composite a) 5 % and 10% wt. residual ceramic.

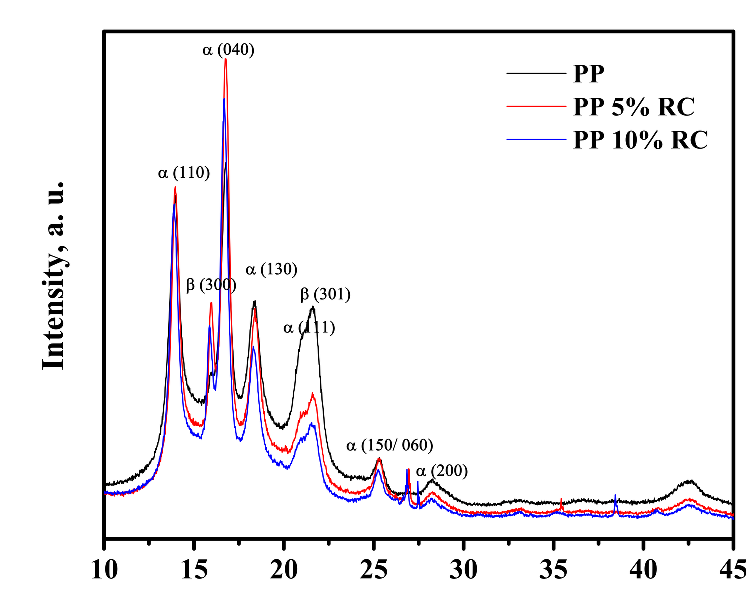


Fig. 4. XRD composite a) 5 % and 10% wt. residual ceramic.

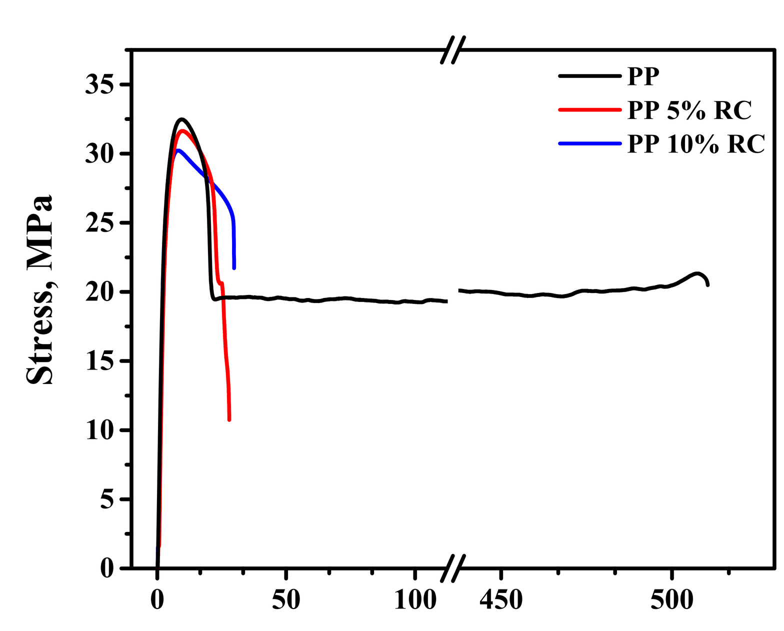


Fig. 5. Stress-strain curve of polypropylene and composite 5 % and 10% wt. residual ceramic.

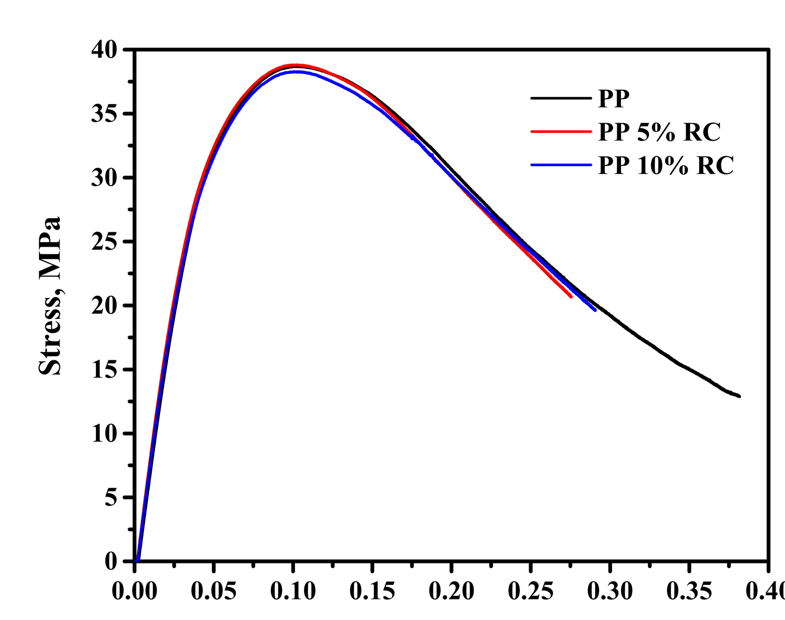


Fig. 6. Stress-deflection curve of polypropylene and composite 5 % and 10% wt. residual ceramic.

Conclusions

According to study conducted in the polypropylene composite with the residual ceramic, it has the following conclusions: it can be seen that the particle distribution is homogeneous in a both composition. It not has been observed any affect the mechanical behavior of the polypropylene, since the values of the mechanical properties remain similar due to low adhesion matrix/ reforcement. The amount of RC decreased ductility in the polypropylene. The composites hardness did not showed a change important of 80-90R with respect the PP. Similarly, It can be determined the presence of the α phase (monoclinic) and β (hexagonal) according to the characteristic planes for both phases. Importantly, the diffraction pattern presented an additional peak at 42.5 °, the plane not has been reported in the literature.

References

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