11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Processing of PVDF/PMMA blends by high-energy ball milling

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Abstract – In this work, PVDF and PMMA with 20 and 80wt% of PVDF were blended in a high energy ball milling using two different ball-to-powder ratio, 1:25 and 1:75, during 2 hours. TGA analysis were performed in the powder obtained in the two BPR conditions. The results showed that the two different BPR conditions did not have a significant influence in the degradation of the blends studied as well as PVDF and PMMA, which presented a thermogravimetric curve according usual mechanism.

Process strategies have been developed to promote and retain intimate (ideally submicron) mixing in polymer blends. Recent studies have demonstrated that solid state mechanical alloying performed at ambient or cryogenic temperatures constitutes an effective means of producing polymer blends wherein phase domains measure less than 100 nm [1]. The ball-to-powder weight ratio (BPR), is an important variable in the milling process. The BPR has a significant effect on the time required to achieve a particular phase in the powder being milled. At a high BPR, the number of collisions per unit time increases and consequently more energy is transferred to the powder particles [2]. However, a reduction of the average molecular weight, owing from the cleavage of covalent bonds due to the mechanical impact during milling can occur in this type of processing [3].

In this work, binary mixtures of PMMA and PVDF with 20 and 80wt% of PVDF were prepared first by mixing in a IKA A11 mill and after in a Spex 5100 using a BPR of 1:25 and 1:75, during 2 hours. The mechanical mixing was conducted at ambient temperature.

TGA analysis showed that PMMA processed in BPR 1:25 condition begin its degradation process at 150°C, a similar temperature than PMMA processed in BPR:1:75 condition. However, the thermogravimetric curves of PMMA and PVDF/PMMA 60/40 in BPR 1:25 condition show two degradation peaks. This multiple weight losses which are observed from approximately 200 to 450°C for pure PMMA is consistent with a previous report [4]. PMMA begin to degrade slowly at 220°C, and then 40–47% degrade in the temperature range 220–270°C [5]. It can be observed that in both BPR conditions, PVDF begin its degradation at 400°C. The PVDF/PMMA 80/20 blends show a unexpected behavior in the BPR 1:75 condition, because the onset temperature is lower than the BPR 1:25 condition, which behavior is similar than pure PVDF, maybe due to inefficient milling process.

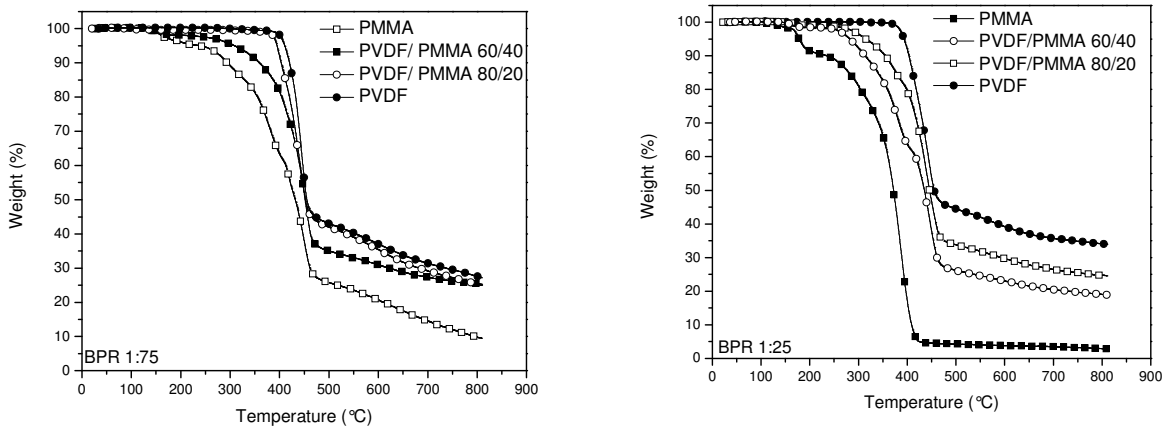

Fig.1. Thermogravimetric curves of PVDF, PMMA and its blends in (a) 1:75 BPR condition and (b) 1:25 BPR condition.

References

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