NOVEL ORGANIC SOLVENT-FREE PURIFICATION OF POLY (PROPYLENE CARBONATE): TAILORING THE COMPOSITION AND THERMAL PROPERTIES

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The report is based on our recent work[1] and departs from the societal aspect of utilization of carbon dioxide as environmentally-benign feedstock to synthesize polymers. Herein, the main focus is on the study of the purification and stabilization of poly (propylene carbonate) synthesized from the reaction of carbon dioxide and propylene oxide using a zinc glutarate catalyst. The raw polymer comprises primarily, in addition to the polyalkylene carbonate, cyclic propylene carbonate (CPC) which acts as plasticizer and catalyst residues which are detrimental for the thermal stability. Inherently PPC has a low decomposition temperature which is a limitation for its processing and application. It is therefore necessary, as a post reactor step, to tailor the amounts of CPC, catalyst residues and improve the thermal stability, all of this in order to facilitate its processing and achieve a suitable mechanical performance from the material.

The effect on the thermal stability and mechanical performance of an aqueous solid-liquid treatment, free of organic solvents, and in the presence of maleic acid is studied on raw PPC using FTIR, ^{1}H-NMR, AAS, DMTA and TGA characterizations. From FTIR it is found that the content of CPC decreases. This is reflected in the increase of T_g and of stiffness as

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[1] Carlos Barreto, Eddy Hansen, Siw Fredriksen, Novel solventless purification of poly (propylene carbonate): Tailoring the composition and thermal properties of PPC, Polymer Degradation and Stability, Volume 97, Issue 6, June 2012, Pages 893-90410.1016/j.polymdegradstab.2012.03.033.

measured from the DMTA. A significant amount of zinc residues is found after the treatment and quantified using AAS and an outstanding improvement in the thermal stability is found in the TGA characterizations (Fig. 1).

The unexpectedly high increase in the thermal stability of the PPC materials after the treatment may be explained by considering the effects of residues of zinc and maleate species on the PPC material. Based on ^{1}H-NMR and AAS investigations, it is hypothesized that the resulting zinc species and the carbonyl groups in the polymer enable metal-ion coordination and, consequently, a stabilization that explains the unexpectedly high thermal stability of the PPC material.

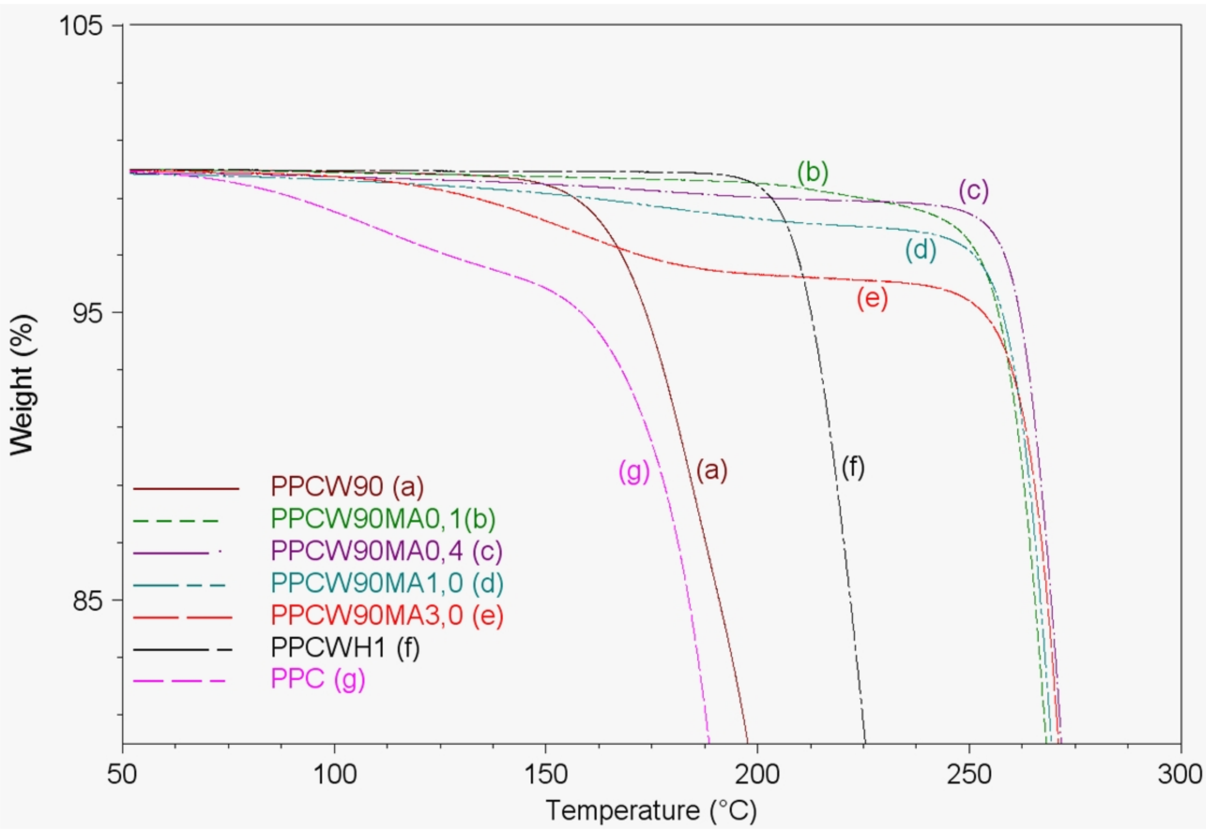

Fig. 1 TGA characterizations (N_2-5°C/min) of raw PPC (g), PPC “free” of metal residues (f) purified using a regular solvent / $HCl_{(aq)}$ based purification, PPC samples purified using the treatment in aqueous maleic acid (MA) treatment at various MA concentrations (a-e)