Review Article

A Literature Review: Non-Recycled and Recycled Polycarbonate / Acrylonitrile butadiene styrene Blends

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ABSTRACT

This literature review on Polycarbonate (PC) / Acrylonitrile butadiene styrene (ABS) blend represents a systematic and relevant background investigation on the various properties like mechanical, morphological and thermal properties of PC/ABS blends. This study also provides the information about the reactive compatibilizers and flame retardants on the properties of virgin as well as recycled PC/ABS blends. The effects of the inherent properties of the materials ABS and PC on the blends also discussed. The variation of rubber content in ABS and their role on property change of blend. Some experimental factors to increase the miscibility were also studied. The variations in the PC and ABS blend compositions and their effects on the compatibility, methods of preparation and the physical properties are reported.

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INTRODUCTION:

Polycarbonate is an amorphous, transparent engineering thermoplastic which gained popularity due to its durability, high impact strength, high dimensional stability, good colouring properties as well as light in weight and widely used for its versatility. ABS is an engineering thermoplastic which is well known for its ease of processability, fabrication and low cost which possesses high chemical and abrasion resistance, excellent impact strength and dimensional stability. There are two phases present in ABS: Styrene Acrylonitrile (SAN) phase and Butadiene phase. The toughness of ABS is obtained from butadiene phase and styrene adds better finishing like glossiness which imparts attractive feel and to touch.

PC is hard to undergo processing due to its high melting point and high heat distortion temperature (HDT), whereas ABS possesses comparatively low melting point, so it is easy to process a polymer with good processability and enhanced properties. PC/ABS blend is unified for its better processability, higher mechanical strength as well as good thermal properties which reliable for application in automobile industries, electrical and telecommunication appliances. PC/ABS blend is well known for its aesthetic uses like door parts, production of assembling items.

Now a day's plastic has gained popularity due to its widespread applications. Even tough in extreme end use fields like automotive, aerospace, electronics and electronics industries prefer plastics for various outer part as well as shields. Some high-performance thermoplastics like ABS, PC, PS and PMMA are vigorously used in automotive parts as well as electrical and electronic appliances.Thus, engineering thermoplastic as well as their blends have notorious contribution in high end use products.

Here the discussion grabs attention on the use of PC, ABS and their blends in various automotive parts and electrical and electronic equipment due to their high mechanical, thermal, morphological properties and high dimensional parts. In current situation the development of technology has increased the consumption of these electronic appliances. These equipment after their particular life span (EOL) are considered to be waste, which are hard to just throw away. The main cause is they are not biodegradable which causes several environmental issues. Recycling of these high-performance plastic products is the best option to avoid these problems. This paper also provided us a glance about the physical properties retention of the recycled PC, ABS as well

as their blends obtained from automotive parts like dismantled car parts and waste electrical and electronic equipment (WEEE). The use of regrind PC/ABS blends through several recycle process is also reported by various authors.

A systematic investigation was carried out aiming the comparison among the mechanical, morphological and thermal properties of different composition and type of PC/ABS blend. In order to provide the necessary background for systematic analysis, this literature review is presented.

PC/ABS BLEND:

The miscibility behaviour of ABS/PC blend was studied by *Sara Aid et al* [1]. The large molecular size of the polymer chain of ABS and PC and high interfacial tension between the polymers causes a big flaw for developing a miscible polymer blend to achieve a synergetic performance. ABS/PC blend was prepared in two composition ratios i.e. 70/30 and 30/70 respectively and the blending was carried out by a classical twin screw extruder and dissolution method in a common solvent Tetra Hydro Furan (THF).FTIR data showed some interactions between ABS and PC from the blend prepared by solution process without any effect of the solvent in the spectra. It is observed from DMTA data that the blends prepared by extrusion process showed 3 transitions with high difference from lower to higher temperature while the blends prepared by solution method showed 2 transitions with a minute difference which implies dissolution method enhances the blending characteristics. The dissolution method has great significant on miscibility of ABS/PC blend rather than extrusion method keeping an eye on health and safety precautions.

O.O Santana et al.[2]studied the miscibility and the interfacial adhesion behaviour of PC/ABS blends. The blend composed with a Bisphenol-A type polycarbonate and ABS comprised of 25 % of styrene and 5% of butadiene (a core shell terpolymer). Blending followed melt mixing in a twin-screw extruder.From the DSC observation, PC/ABS blend was found to be partially miscible for most of the compositions of PC and ABS. This result was obtained possibly due to the separation of oligomers between the polymer phases. ABS possessed higher mixing and interactive effects than that of PC. The solubility of the ABS increased with the reduction in PC content.The effective transmission of stress in between the polymeric phases at yielding was shown in case of minimum ABS content. The rule of mixture held good for the ABS with mass 10 %, resulting strong

interfacial adhesion between polymeric phases of PC and ABS.

An investigation was carried out on the effects of compatibilizers like Maleic Anhydride grafted Polypropylene (MAP) and epoxy resins on the mechanical properties as well as morphology of the PC/ABS blends by *S.C. Tjonget al.*[3]. Thecompatibilizers were added in 10, 20, 30 and 40%weight of ABS (M) [MAPtreated ABS] and 0.5, 0.1, 2.0phr of epoxy resins composition ratio were added to the ABS with the help of a Brabender mixture and then they undergo blending process with PC in an injection moulding machine. The mechanical aswell as morphological data were compared with uncompatibilized PC/ABS blend. The tensile test data showed that in the PC/ABS blend thetensile modulus of PC raised with ABS content, but the yield strength of PCreduces with addition of ABS. Tensile test and also Izod impact test showed that the MAP compatibilizers PC/ABS blend with added 2phr of epoxyresin with a composition ratio 70:30 exhibited high impact strength as well asductile behaviour which implies the compatibilizers had no significant effect when the ABS content in the blend is more than 40% of weight percentage. The larger the ABS content poorer is the mechanical properties of the polymer. From the SEM observation it wasobserved that incorporation of MAP and epoxy resins as compatibilizers improved the mechanical strength of the blend by reducing the size of the dispersed ABS.Hence it is concluded that addition of both the compatibilizers improve the compatibility of the blend thus improve the mechanical properties.

The effect of a reactive compatibilizer like EVA-g-MAH on the mechanical properties like tensile strength, strain at break and notched charpy impact strength was studied by *Farzadfaret al.*[4]. The EVA-g-MAH used in this research was of grafting degree 1.5 %. PC/ABS in a composition ratio 70:30 blended with the compatibilizer of different compositions like 0, 2, 5 and 10 (phr) in a twin-screw extruder machine. Experimental data of yield strength of the blend showed reduced value while the elongation at break percentage raised up with the increase in compatibilizer concentration. EVA-g-MAH reduced the surface tension of the blend hence increased the compatibility between the PC and ABS. Notched Charpy impact strength also showed an increased value with the increase in the concentration of compatibilizer to its optimum concentration.The morphological observations from SEM micrograph represented ductility in the fractured surface of EVA-g-MAH compatibilized

blend while as the uncompatibilized blend showed brittle behaviour. Hence the EVA-g-MAH satisfied the required aspects for an efficient blend of PC/ABS.

S. Balakrishnaet al.[5]researched the effects of the maleic anhydride grafted ABS upon the mechanical properties of the blend by blending it with PC in comparison with unmodified PC/ABS blend.From the plot of tensile strength, the blend prepared from the PC/MABSexhibited positive bending for tensile modulus while PC/ABS blend did not show any significant result and the tensile strength was maximum for PC/MABS blend. The flexural modulus did not hold any significant variation but the flexural strength of PC/MABS was obtained relatively higher. From the data obtained by notched impact test the impact strength of PC raised with the incorporation of MABS but PC/ABS blend exhibited negative bending. SEM characterization provided information that the fixed cavities of PC were efficiently occupied by the maleic anhydride treated ABS which exhibited better interfacial interaction than that of untreated ABS in the blend which exhibited rather huge cavities with less interfacial interaction.

Synthesis of a reactive type compatibilizers like amine functional SAN to enhance the compatibility of the PC/ABS blends was done. The blending procedure was carried out in a twin-screw extruder. The formation of SAN amine compatibilizers was carried out by reacting styrene, acrylonitrile, maleic anhydride terpolymer with 1-(2-aminoethyl) piperazine (AEP). FTIR characterization exhibited all the secondary amines were present in the pendant groups due to complete reduction of maleic anhydride functionality in the SAN amine. NMR characterization revealed rise in the peaks of urethane and phenolwith the loss of both amine and carbonate functionalities.TEM observation supported improved morphology upon incorporation of compatibilizers to the blend matrix, due to decrease in surface tensionbetween the PC phase and ABS phase.1% SAN amine grafted blend tended to enhance the strength of melt in comparison with the un-compatibilized one. This experimental observation was carried out by *G.S.Wildeset al*.[6]

The study upon enhancement of the mechanical properties of PC/Abs blend was executed by *Xiangfuet al.*[7]. They compared PC/ABS blend using compatibilizers ABS grafted with Maleic Anhydride (MAH) and studied on its morphological and mechanical properties.This showed thatPC/ABS blends in which ABS-g-MAH were used has a notched Izod impact strength than

ABS/PC blend without any compatibilizers. Using ABS-g-MAH in blend also enhance the other properties such as tensile strength, vicat softening temperature (VST) and flexural strength but not as much as Izod impact strength property. Depending on the loading of ABS-g-MAH and the degree of grafting (DG) of MAH in ABS-g-MAH, the impact strength of the ABS/PC blend increases or decreases.They also studied the DSC analysis and SEM observation which showed that ABS-g- MAH could significantly improve the compatibility of the ABS/PC blend, so act as a good compatibilizers.

The effect of ABS type on the mechanical and morphological properties was the matter of focus according to *Lombardo et al.*[8]. The experiment went ahead with two types of ABS such as mass or bulk ABS with 16% rubber content on larger rubber particle size of 0.5 to 1.0 and another type of ABS is emulsion produced ABS with 50 % rubber content of relatively smaller rubber particle size (0.1 to 0.5). The mechanical properties of the blends composed withemulsion-based ABS showed lower value of tensile strength and modulus but it showed efficient toughness as well as sharp notched izod impact test value at standard room temperature near glass transition temperature. The properties obtained are resultant of higher rubber content in emulsion-based ABS. The experiment showed that the lower rubber particle caused toughness in the blend at low temperature.The morphology of the blend was observed from TEM micrograph. The variation of ABS material type with 15 % rubber content was observed. The rubber particle size as well as content was evident from photomicrograph. The dispersion was found good for the small rubber particle size rubber i.e., emulsion-based ABS type showed agglomerated particles.

Nigam et al.[9]investigated the effect of rubber content on the physical properties of PC/ABS blends. The polymer blend was prepared by taking PC and ABS in various compositions ratios like 100/0, 90/10, 70/30, 50/50, 30/70, 10/90 and 0/100 in a Torque Rheocord machine. The mechanical property study exhibited that upon addition of ABS in an increasing order, the tensile strength, impact strength as well as elongation at break went on decreasing. The impact strength of the blend with 10% ABS which contains higher rubber content was found to show additivity. The blend with 50/50 composition ratio possessed minimum value for elongation and impact strength. The thermal property observation from DSC study was found to be similar with the theoretical observation single broad

was obtained for lower ABS for minim um rubber content. For the blend of PC/ABS there were two transitions signified partially miscibility of the blend. The blend with 10 % and 70 % ABS was the optimized composition for better dissolution and the increase in rubber content decreases the thermal stability PC with the addition in the blend.

The effect of PC content on the mechanical property of the PC/ABS blends using two types of ABS materials used comprising of different flow rates in the blending i.e., termed as ABS-747 and ABS-757 was experimented by *A.C. Wong et al.*[11]. The blending of both types of ABS types with PC took place in a Twin-screw extruder separately in various composition ratios like 90/10, 70/30, 50/50, 30/70 and 10/90% of PC and ABS respectively.From the mechanical tests the blend with ABS-747 was found to be less significant as it was incompatible with the PC. But the susceptibility of the ABS-757 was with even lower PC content (30 %). Some synergistic effects were found in case of PC/ABS-757 blends. Significant presence of PC increased impact toughness for both types of blends. Impact toughness was only higher for the ABS-747 type of blend at lower PC content (<40 %). Tensile yield and yield strain was also greater for the blend with ABS-575.SEM micrograph also provided evidence of the fracture surface behaviour in accordance with impact toughness of the blend. The blend with ABS-757 was found to possess smoother and continuous morphology than that of ABS-747 as blend with ABS-747 went under plastic deformation upon applying impact load. Increase in PC content increased uniformity in the surface. 70/30 composition was the optimum composition with better mechanical properties.

Khunet al.[12] investigated the thermal, mechanical properties of PC/ABS blends having different ABS content.TGA results showed that the thermal stability of the ABS is much lower than that of the PC so the thermal stability of PC/ABS blends decreased with increasing ABS content. Since the hardness and Young's modulus of ABS were lower than that of PC, with increasing ABS content the hardness and Young's modulus of PC/ABS blends decreased remarkably. It was also observed that as the tensile strength of ABS is lower than that of PC, the tensile strength of PC/ABS blend with 10 wt% of ABS showed higher tensile strength than that of PC because of better miscibility and processability of the blend.The above data indicated that PC/ABS blend with 10 wt % of ABS show better tensile strength and wear resistance.

Lee et al.[13]prepared PC/ABS by blending 2 different molecular weight PC with ABS under high-shear rate and investigated the mechanical properties and size of ABS dispersed phase. Morphology changes were observed by SEM. High molecular weight PC (PC1, MW 13700) and low molecular weight PC (PC2, MW 9700) and ABS containing 15% polybutadiene was used for this experiment. The antioxidant used here was Bis-(2, 4-dicumylphenyl) pentaerythritoldiphosphate. PC (70 %) and ABS (30 %) were blended by twin screw extruder and specimen was prepared by high shear processing extruder.From the SEM images it was observed that as screw speed increased the dispersed phase size of both PC1/ABS and PC2/ABS became smaller but the drop size of dispersed phases decreased sharply in PC2/ABS than those in PC1/ABS under high-shear rate processing. Similarly, at a fixed screw speed the dispersed phase size of both PC1/ABS and PC2/ABS decreased upon increasing the processing time. It was noted that until 10 second the effect of shear time was negligible for PC2/ABS BUT small for PC1/ABS but when the processing time increased the size of dispersed phases of PC2/ABS decreased largely than those of PC1/ABS.The highest tensile strength and elongation for both PC1/ABS and PC2/ABS were observed at 1000 rpm for 20 seconds but when screw speed increased due to shear-induced degradation both tensile strength and elongation reduced. At a fixed screw speed (1000 rpm) it was noted that until 10 seconds the tensile strength of both PC1/ABS and PC2/ABS increased. When the processing time increased to 40 seconds the tensile strength was almost maintained. The elongation did not decreasesignificantly. In the graph of mechanical properties vs reciprocal of size of dispersed phase, PC1/ABS showed improved mechanical properties whereas PC2/ABS showed sharp reduction in mechanical properties as it was assumed for PC2/ABS that the increase in high-shear force makes the drop size smaller and shear-induced degradation at the same time for PC2/ABS. The above results clearly suggested that the PC/ABS blending with PC having higher molecular weight under high-shear processing enhanced compatibilities, reduced size of dispersed phases to improve mechanical properties and reduced the shear- induced degradation.

The analysis of the effect of reactive type flame retardant (FR) viz. Brominated Epoxy Resin (BER) on the mechanical as well as rheological properties of the PC/ABS blend was done by *J.I. Sohnet al.*[14]. In the blending BER with a fixed

molecular weight and density was added to the blend with fixed amount of antioxidant like Antimony Oxide with the polymer PC and ABS in a twin-screw extruder. From the observed mechanical test data, the flexural strength as well as the impact strength values was obtained to be lower for blend with FR that of blend without FR and lower value was also obtained for addition PC. The blend with FR exhibited great value of tensile yield. The HDT value increased with the increase in PC content and showed high HDT value for blend containing FR. The PC/ABS blend under SEM observation represented fractured surface with less interaction of PC and ABS.

Experimental studies of flame retardant (FR) like Brominated Phosphate in the PC/ABS blend in comparison with a commercially available PC/ABS blends with FR Triphenyl Phosphate (TPP). The commercial blend was of PC/ABS concentration ratio 3:1 along with 14 % of TPP. Further another blend was prepared with PC, ABS from 3:1 to 1:1 concentration ratio and both the FRs like TPP as well as brominated phosphate were compounded separately in a twin-screw extruder.Brominated phosphate was found to be more effective than that of TPP and it can be significantly replaced by brominated phosphate. According to *J. Green et al.*[15] the flame retardancy of the blend was enhanced at a lower concentration of FR i.e., at 6% for UL 94 V-0/5V test. Cone calorimetry test also evidenced maximum ignition time as well as lower heat releasing effects upon addition ofbrominated phosphate than that of TPP.

Debbahet al.[16] investigated on the effects of compatibilizers like SEBS-g-MAH on the mechanical properties of PC/ABS blends. The blending procedure took place in various compositions of PC and ABS with the compatibilizers ratio 1, 3, 5 % in a twin-screw extruder. Upon adding 1 % of SEBS-g-MAH to their blend exhibited a significant increase in the tensile strength value specifically when the PC composition is 80 %. 1 % of compatibilized PC/ABS blend showed enhanced stiffness while 3-5% or compatibilizers showed lower value of stiffness. 1-3 % of compatibilizers helped in the enhancement of the elongation at their break and upon adding SEBS-g-MAH increased value of impact strength as well as other mechanical properties.The morphological observation showed that SEBS-g-MAH added enhancement in the interaction between PC and ABS surfaces which is a characteristic of co-continuous morphology. Thermal properties of the PC/ABS blends were studied with DSC as well as DMA characterization. A slight

shift towards higher temperature was obtained which resulted high difference in the T_g of both PC and ABS phases which imparted an enhanced compatibility. TGA was carried out to determine the effect of compatibilizers on the thermal stability of the blend which was improved upon addition of stabilisers. The compatibilizers with 1wt % represented best thermal stability.

The test of the influence of compatibilizers on flame retardant type PC/ABS alloy was exhibited by *Chiang et al.*[17]. They considered PC/ABS alloy of composition (80/20) and its flame retardant property was studied by DSC. PC and ABS pellets were dried for 120^0C and 80 ^{0}C separately in vacuum for 4 hours, then blended with the help of a twin-screw extruder at 240-260^0C and screw speed of 110 rpm. Then the pellets were processed in an injection moulding machine to prepare test specimen. Maximum notched izod impact strength was observed in PC/ABS alloy with composition 80/20. DSC observed two glass transition temperatures implying alloy was not compatible. Then 3 types of compatibilizers Methacrylate-Butadiene-Styrene (MBS), Ethylene-Vinyl-Acetate (EVA) and Styrene-Maleic Anhydride (SMA) were added. The alloy with added compatibilizers showed one T_g value in DSC showing compatibility of alloy. To study morphology, samples were frozen in liquid nitrogen. Flame retardants raised the LOI value but lowered the mechanical properties of PC/ABS alloy. On adding 3phr of MBS, notched Izod impact strength increased for PC/ABS. alloy containing 10 and 15phr of flame retardants. Incorporation of 1 and 3phr EVA into alloy containing 10 phr flame retardant increased impact strength while 5phr EVA caused decrease in impact strength. Impact strength of flame retardant PC/ABS alloy was affected by addition of SMA.

Numerous injection moulding cycles of PC/ABS blend using the re grinded blend obtained from previous injection moulding cycles was done with the aim to experience the influence of reprocessing cycles upon the physical as well as morphological properties of the PC/ABS blends. According to the experiment done by *J. Kuczynskiet al*.[18] there was total 8 re-processing cycles and various properties were studied after each of them.IR spectroscopy revealed no significant changes in the spectra upon aggressive re processing of the blend.Agglomerate formation is a possible result of overheating during the excessive reprocessing. However, no such result was obtained from the TEM micrograph data. According to the experimental data obtained there were no such increase in

agglomerate formation after the 8th reprocessing cycle, which evidenced the possibility of reprocessing of PC/ABS blends for numerous times.

K. Nishino et al.[19]elucidated the enhancement in the hydrolytical stability as well as impact strength of the blend upon incorporation of reactive co-polymer such as Styrene, Methyl Methacrylate and Maleic anhydride. A metal salt like Magnesium Stearate was also added to the polymer blend. The PC/ABS blend comprised of various types of ABS. The blending procedure was carried out in a twin-screw extruder.The impact strength was found to be increased upon effective addition of reactive polymer and the magnesium stearate (metal salt), resultant of enhanced compatibility between the polymer phases.The MA group present in the reactive co-polymer reacted effectively with the hydroxyl group of PC created upon hydrolysis with metal salt and PC. The resultant grafting co-polymer effectively stabilised the blend interphase between PC and ABS.

The experimental observation on the dynamical properties of PC/ABS blends was carried out by *J.MAS et al.*[20]. The blend comprised of a bisphenol-A-PC and ABS with 25%of Acrylonitrile and 5% of butadiene. The blending was done through melt blending.According to thermal property observations, the phase separation occurred in the polymer blends, the transfer of oligomer content in ABS occurred to PC through the melt blending, which resulted relaxation in dynamic properties. The result indicated partial miscibility of the blend.From the observed morphology, ABS was found to be the dispersed phase in PC rich composition. The increase in rubber content caused increase in the size of the dispersed phase. FTIR characterization detected the absence of polarity in the blend, which needs to be further enhanced by processing.

The tensile deformation characteristic of PC, ABS and PC/ABS at different strain rates was countered. The blending was carried out in 80/20, 60/40, 50/50 and in 40/40 ratios by melt blending in increasing order of strain rates.From the experimental observation done by *Yin et al.*[21] a true stress-strain curve was observed for the polymers as well as for the blends, in which strain rate played an important role. The stress-strain curve exhibited large deformation upon applying strain. Yielding stress went up with the increase in strain rate possibly due to the strain rate increase inhibits the functioning of molecular chain became stiff. The plastic deformation increases upon increase in strain rate which caused decrease in fracture strain. The plastic

deformation occurred due to increase in the number of deformed polymer chains.

Khan et al.[22]studied mechanical properties of PC/ABS blends in evidence with morphological study. The blending procedure was carried out in Brabender Twin Screw Extruder with 15 %, 30 %, 50 % and 70 %, 85 % of ABS content in the PC blend.The mechanical study provided information about decrease in tensile strength with the increase in ABS content in the (Law of Mixture). Elongation at break exhibited non-monotonous value with the increase in ABS content and the blend possessed smaller elongation at break than that of pure PC. PC rich polymer blend was the blend with higher impact strength than blend with ABS rich content.From the morphology study the ABS phase was represented as sphere fused in PC phase. The ABS rich blend

The miscibility and synergetic effect of impact strength in PC/ABS blend was reported by *Chun et al.*[23]. From experimental data synergetic effect was observed for PC content in a range from 20-80 % and lowest butadiene content of 18 %. As the impact strength of the blend affected by the butadiene content it was observed that the lower the rubber particle content in the blend more is its impact strength and can be further enhanced.

Some of the mechanical as well as thermal properties of PC/ABS blend were studied by *Kracheet al.*[24]. They studied various properties with the aim of obtaining the highest result of each study with the optimum composition without incorporation of any compatibilizers. The blending of PC/ABS took place in various compositions in a two-roll mixture. From the Tensile test data, a reduction of tensile strength was observed linearly with the decrease of PC content upto 30 %. The strain break remains constant for the blends with 30-60 % of PC composition.

The different properties of PC/ABS blend with varying composition of PC and ABS were analysed by *Greco et al.*[25]. These blends were prepared by Brabenders like apparatus and compression moulded in sheets.They observed in improvement of PC processability by ABS addition. A DSC examination confirmed T_g shift of the blends. For the mechanical properties two major test were performed. One is flexural impact test on sharply notched specimen at a very high deformation rate where they found a strong synergetic effect in a composition range of 20-30 % of ABS. Second one is tensile stress strain test on un-notched specimen at a very deformation rate showing a decrease in PC ductility in blend with addition of ABS. the adhesion between PC and ABS domain was confirmed by a comparison

of experimental data of young's modulus Vs blend composition with Kerenrs model prediction.

This investigation was done by *Chaudhary et al.*[26] on the phase morphology of PC/ABS polymer blends by taking into consideration of its processing conditions such as blending temperature (°C), rotor speed (in RPM) and mixing time (in min). ABS having AN, butadiene, styrene of weight 23, 21 and 56% respectively was blended with Bisphenol-A PC by melt mixing process at different temperature in a torque rheometer. At short time a well dispersed PC phase surrounded by ABS matrix was observed. With increase in mixing time both PC and ABS blend phase approached a 'quasi' continuous phase. The dispersed phase shape became more elongated as the temperature increased. At higher blending temperature, the thermal degradation of blend detected by torque value without showing any change in the morphology. With the increase in annealing time the blends of PC/ABS became contract and then reunite when heat is provided. It gives PC dispersed phase morphology. Chemicals from the residual synthesis of ABS caused chain scission in the PC which led to the reduction of blend melt viscosity. Higher mixing speeds did not have a strong influence on morphology.The annealing heat treatment observed the state of morphological stability of PC/ABS blend, this treatment at melt temperature caused a remarkable change in morphology. Under heating pc and abs phases coalesced and shrieked and a PC disperse phase morphology was generated. PC domain size becomes larger with increasing in the annealing time.

Shingwuet al.[27]studied on the PC/ABS blends and their changing properties depending upon the physical changes of each content. They observed that the melt viscosity of PC/ABS blends is lower than that of pure ABS and significantly lower than PC with increase in the molecular weight of the PC in the blend, the low temperature fracture toughness improved but it caused a disadvantage of higher melt viscosity. So, during the selection of PC for PC/AB blend we must compromise between the advantages of toughness due to higher molecular weight PC and the disadvantage of higher melt viscosity.

In this paper *G wildes et al.*[28] studied the fracture behaviour of the PC/ABS blends and experimented the effect of reactive compatibilizers like SAN-amine grafted ABS. the fracture specimen with standard as well as sharp notchededges seen 1 under Izod and single edge notch three-point blend tests. The virgin PC material with high molecular weight was found to

be independent of ligament length. The blends of PC/ABS obtained were tougher for thick as well as thin sample. The SAN amine compatibilizers (1%) increased toughness of the sample. From the TEM analysis the obtained result evidenced less toughens in fractured surface for the blends without any compatibilizers. The dispersed ABS phase possessed larger domain which resulted above observation. But the blends with compatibilizerspossessed finer dispersed morphology due to larger ABS domain size, which was effective reduce by a SAN- amine compatibilizers.

This paper was studied by *Mitsuoet al.*[29]on the effect of morphology o the tensile properties and fracture properties of PC/ABS polymer alloy. They did a comparative study in between PC/ABS alloy with composition of (60/40) and (80/20). A co continuous phase structure is formed in PC/ABS blend composition. Yield stress and tensile strength of PC /ABS alloy follow law of mixture. Young's modulus of this alloy increase from 0wt% to 40wt % of ABS and decreases after 40wt % to pure ABS. K_m of PC/ABS (60/40) has maximum value but $d_{KR/da}$, implies most excellent fracture resistance and also largest impact fracture toughness. SEM observation showed PC/ABS (80/20) surface is rougher than PC/ABS (60/40) and PC/ABS (60/40) and (50/50) had most similar surface structure. TEM showed PC/ABS (80/20) are deformed more than other. Toughening mechanism of stress released by separation of interface between each phase and severely damaged deformation of rubber particles during fracture.

Yang et al.[30]enquired on PC/ABS blend and effect of 1. Viscosity ratio 2. Temp. on the viscosity ratio 3. Extruder screw location and 4. Compatibilizers on the morphology of PC/ABS blend. The blend composition of PC/ABS 75/25 and 25/75 were prepared using twin screw extruder. The in-situ morphology studied via the screw pulled out technique. Again, PMMA compatibilizers used for 3wt % and 5wt % to study its effect on morphological and mechanical properties on PC rich PC/ABS blends. The plot for the PC/ABS viscosityratiov_{PC} / v_{ABS}versus the shear rate showed a gradual rise in the curve upto acritical shear rate and then showed asymptotic character. Whereas with increase temp VPC/VABSdecreased. Here we concluded the melt viscosity of PC is thermally more sensitive than ABS over temperature range. The results were compared with respect to screw of twin screw extruder showed gradual reduction in size towards the die exist or the minor phase domain. 3wt % PMMA in PC/rich PC/ABS blend showed greatest ABS

domain size reduction. 5wt % PMMA in this blend showed impact property lower than without addition of PMMA. A minimal improvement was observed in tensile strength.

RECYCLED PC/ABS BLEND:

Xiaodonget et al.[31] researched to upgrade the mechanical properties of recycled engineering plastic by applying technique. They took dismantled Volvo cars into consideration and studied four different plastics. Those are poly acrylonitrile butadiene styrene (ABS) and ABS-Polycarbonate (ABS-PC) as major component and PMMA and poly amide as minor components. The blending of recycled ABS and PC/ABS (70/30) with a small amount of methyl methacrylate butadiene styrene which act as core shell impact modifier give the product better impact properties than any of itsindividual components. Adding 10 % of PMMA in PC/ABS blends made an improved property profile. As PA is an incompatible component it should be preferable to sorted out from the mixture product.By adding antioxidant and metal deactivator we can't enhance the mechanical properties of the product. Charpy impact strength, two toughness measurements and J- integral method show a positive result for such blends.

This experiment was studied by *Balart et al.*[32] to recycled polymer waste from, electrical and electronic equipment i.e., ABS consisting of a SAN thermoplastic matrix and polycarbonate (PC). This blend of residues ABS and PC was prepared by melt blending process.The FTIR spectra of ABS/PC waste blend and virgin ABS/PC blend were compared. In the waste ABS/PC blend a small degradation in ABS was observed due to presence of a polybutadiene rubber but there was no degradation found in PC. By identifying two glass transition temperature using Differential Scanning Calorimetry (DSC) we observed certain miscibility between ABS and PC. Small degradation in elastomeric component and partial miscibility between two components caused some degradation in mechanical character. Composition of 20-80 % PC by weight showed decrease in both mechanical resistant and ductile properties. The composition range 10-20 % wt. of PC did not show decrease in ductile properties and processing remained same as virgin ABS/PC blend.Scanning ElectronMicrograph (SEM) showed certain lack of adherence between SAN phase with PC due to lack of miscibility and degradation of polybutadiene spheres that act as stress concentrator. The equivalent model (EBM) determines an

interaction/adherence parameter 'A' which is lower than 1 and showed lack of interaction.

Balart et al.[33]investigated thermal properties in accordance with 'kinetic parameters' calculation such as activation energy by auto catalytic model. The optimal blend of PC/ABS was obtained from WEEE. The effect of each component upon thermal degradation of the blend was studied.According to thermal behaviour observation carried out through TGA analysis, PC degradation was obtained at comparatively higher temperature than that of ABS. The addition of minute amount of ABS led to show curves of degradation nearly similar to those of pure ABS. The SEM micrograph study evidenced about the interaction of both PC and ABS during the thermal degradation. The autocatalytic model was found to be useful as the value of α was greater than 0.4 which exhibited similarly between theoretical data and experimental data. The autocatalytic model was suitable for the blend where PC existed as continuous phase.

This process where both virgin ABS (PC-ABS) blend and post consumed ABS-PC blend were reprocessed and reformed upto 3 times were studied by *R. Scaffaro et al.*[34]. We observed the variation in properties with respect to PC-ABNS content and reprocessing cycle no. Both the ABS used were injection moulding grade. A modular co rotating twin screw extruder has been used to prepare blends used for studies. The temperature 190-200-210-215-220-230-235 ^{0}C was applied with rotational speed 200rpm. These products were again re processed 3 cycling with temp.200-215-235 ^{0}C with injection pressure 95 mpa. The tensile properties of ABS/PC- ABS blends decreased during 1st processing but further the no.of reprocessing and PC-ABS content did not affect it. The flexural properties did not affect by PC-ABS content but recycling process cause a small change. Impact strength decreased significantly with both PC-ABS content and recycling process.

In this experiment *Zhao et al*. [35] prepared blends of recycled PC and recycled ABS using vane extruder in order to analyse the mechanical, thermal and morphological properties of the pc/abs blends.The blend showed comprehensive mechanical properties especially enhancement in impact strength as compared to both the recycled PC and ABS at ABS content 20% in the blend. The FTIR analysis detected minute degradation of recycled PC but some degree of thermal oxidation of recycled ABS was observed. When rABS concentration increased, T_g value of rABS phase decreased but $T_g$value of rPC phase increased. The SEM result

indicated that rPC is partially miscible with rABS from these results it can be concluded that vane extruder used for blending of rPC and rABS have significant role in upgrading the mechanical properties.Due to the positive displacement type conveying, short thermal mechanical history and good mixing effect of other recycled plastics can be blended by Vane extruder to upgrade their properties.

Kuram et al.[36]recycled PC/ABS binary blend and polyamide6/PC/ABS (PA6/PC/ABS) ternary blend five times in order to study the effects of recycling process on thermal, chemical, rheological and mechanical properties of the blends.From the FTIR analysis it was observed that there was no change in the chemical structure of both blends with reprocessing. The DSC curves showed that T_m values of blends did not change remarkably with recycling. TGA curves of both virgin and recycled specimens were found to be similar i.e., 2 steps of thermal degradation in both the blends. SEM results showed that repeated recycling did not change surface morphology remarkably.With recycling elastic modulus increased for PC/ABS while impact strength and MFI decreased. However elastic modulus and tensile strength decreased with increasing recycling process while MFI, flexural properties and impact strength increased forPA6/PC/ABS. Basically addition of PA6 into PC/ABS enhanced the flexural properties, MFI and impact strength but worsen the elastic modulus and tensile strength. From the above observations it can be concluded that use of recycled PC/ABS and PA6/PC/ABS could be possible in place of virgin ones and addition of PA6 into PC/ABS blend could be useful as the mechanical properties were improved.

Liang et al.[37]prepared PC/ABS blends using 50wt% virgin ABS, 0-25 % low molecular weight virgin PC and 25-50 % high purity recycled PC in order to keep down the property variation. The rheological and mechanical properties were investigated. All the blends were prepared at a screw speed of 25 rpm in a Brabender twin screw extruder. From the virgin PC/ABS blend study it was observed that blends containing 15 % and 50% ABS content showed lower viscosity while 30 % and 85 % sample showed a little bit higher viscosity than 70 % sample and pure ABS and lower than pure PC. So, it indicated that blending virgin PC and ABS improved processability of PC by enhancing shear thinning behaviour. Due to the multiphase characteristics of PC/ABS blend there happened a complex relationship between composition and rheology or mechanical

properties and yielded PC/ABS blend of different morphologies and properties.PC/ABS (50:50) blend was selected for substituting recycled PC in place of virgin PC as it had lower viscosity, balanced mechanical properties and qualityprocessing behaviour. To modify the molecular weight distribution of recycled PC, a low molecular weight virgin PC was added.The data showed that when recycled PC was used, the viscosity of the blend decreased significantly. When 10% of HF-PC was added the viscosity was higher than recycled PC/ABS without HF-PC but lower than virgin PC/ABS. with further increase in the HF-PC content, the viscosity almost remained same. Subsequently mechanical properties showed drastic reduction. The material became more brittle when 5 % HF-PC was added into 45 % recycled PC. Addition of 10 % HF-PC into 40 % recycled PC recovered the mechanical properties. The properties remained almost same with further addition of HF-PC into recycled PC.This study concluded that PC/ABS with 10 wt % low molecular weight virgin PC, 40 wt % recycled PC and 50 wt % virgin ABS could be usable as it had high recycled content and stable mechanical properties and can be easily processed.

The effect of phosphorous based flame retardants on the blends of recycled PC and ABS polymers, achieved from industrial waste were observed by*Barbara et al.*[38]. The blend comprised of 80/20 ratio of recycled PC and ABS respectively with the incorporation 3 commercial Aryl phosphate flame retardants like BDP, OEP and TPP in 15%. An impact modifier like MBS was also added in 5% to the recycled blend with OEP flame retardants.From the mechanical study the blend with flame retardants as well as the one with impact modifier (rPC/rABS/FR and rPC/rABS/OPE/MBS) represented enhanced tensile and flexural modulus. A diminished value was obtained for the impact strength, tensile strength and flexural strength.The thermal property study that the decrease in T_g for PC phase nearly 40 ^{0}C upon addition of flame retardants, increased the thermal stability as well from the TGA data.FR played a crucial role in the flame retardancy property which was tested positive for UL94 V-0 test.

Farzadfaret al.[39] processeda recycled PC/ABS blend with two different compatibilizers in order to explore the effect of compatibilizers used such as ABS-g-MA. The source of PC and ABS were recycled compact discs and recycled domestic appliances. The blends were prepared in a co-relating twin screw

extruder of composition 70/30 (PC/ABS) using 3, 5, 10 phr of each compatibilizers. The experiment showed the poorer mechanical properties of recycled material blends than that of blends of virgin materials. The using of ABS-G-MA compatibilizers had no remarkable effect on the tensile strength whereas the tensile strength of blends decreased gradually with increasing amount of EVA-G-MA. When 10phr of EVA-G-MA was used lowest value of tensile strength was recorded. With increasing amount of compatibilizers upto 5phr the impact strength increased and after that it decreased or showed no changes. Moreover, the impact strength of blends with compatibilizers increased than that of blends without compatibilizers.SEM photomicrographs showed the blends without compatibilizers have brittle behaviour while the blends with compatibilizers have ductile behaviour in fracture. The experiment showed that the modifier did not restore the properties of blend of recycled materials.

In this experiment *Biswalet al.*[40] prepared a blend of PC/ABS collected from E-waste in addition with a reactive compatibilizerslike ABS-g-Maleic anhydride and also impact modifier like SBS. The blending was done through melt blending technique. The obtained blend in treatment with ABS-g-MAH was found to be effective for compatibilization. The mechanical property was found to be enhanced upon adding compatibilizers in 20% and adding 5% SBS impact modifier. Enhancement of impact property was shown.Thermal study revealed from DSC analysis that addition of compatibilizers improved miscibility was obtained. TGA analysis should minute diminished value for the thermal stability resultant of free radical generation as well as peroxy radicals caused thermal degradation.From the SEM study, it was observed that the ABS-g-MAH played an effective role in reduction of ABS dispersed phase which led to enhance compatibility. Hence, the adverse properties of E-waste can be treated with incorporation of various types of compatibilizers as well as impact modifiers.

Here an investigation was done by *Mahantaet al.*[41] on recycling of plastic waste to enhance its properties. They choose two engineering plastic i.e., PC and ABS from electronic and electronic equipment wastes. They use MA-g-polypropylene (MAP) and solid epoxy resin as compatibilizers in RPC/RABS blend and was prepared by microinjection moulding. Without compatibilizers the mechanical performance of RABS and RPC – rich blend shows negative deviation. Little degradation of RABS affects mechanical performance. On

adding 5 % of MAP as a compatibilizers to RABS/RPC blend showed a positive mechanical performance. With further addition of solid epoxy resin enhanced mechanical performance like tensile strength and modulus as compared to virgin ABS and PC. Again, they added two Nano clays: Colosite 30B and Colosite 15B to RPC rich blend for properties improvement. This caused a positive deviation in thermal stability compared to VABS.

A blend of recycled polycarbonate/acrylonitrile butadiene styrene (R-PC/ABS) with virgin PC (V-PC) and various concentration of a reactive compatibilizers EVA-g-MAH (ethyl vinyl acetate grafted maleic anhydride) was prepared by*Ramesh et al.*[42] and studied the effects of compatibilizers on the mechanical, morphological and rheological properties of these blends. Here MAH was grafted to EVA copolymer in presence of DCP (dicumyl peroxide) and grafting was analysed by FTIR analysis. FTIR data showed the successful incorporation of MAH into EVA copolymer.The results showed that with increasing amount of reactive compatibilizers i.e., 10 wt % of EVA-g-MAH in R-PC/ABS enhanced the impact strength and % of elongation. But the tensile strength and tensile modulus reduced slightly due to rubbery effect of EVA. From the SEM images it was observed that there was better surface interaction which led to better miscibility. The FMM micrographs confirmed the reduction of particle size of the dispersed phase caused by the effect of reactive compatibilizers. In accordance with mechanical and morphological properties, the thermo-mechanical and rheological properties showed better compatibility due to the presence of EVA-g-MAH.The above results came to an end with the fact that addition of 10wt% EVA-g-MAH with 30 wt % virgin PC in recycled PC/ABS blend increased compatibility of the blend.

Elmaghoret al.[43] recycled waste PC by blending with maleic anhydride grafted ABS (ABS-g-MA) in order to improve the toughness of waste PC. Here they looked forward to the role of MA grafting and the relationship among the grafting, morphology and the impact strength which was a measure of toughness. ABS, maleic anhydride and dicumyl peroxide were mixed in a Brabender mixer to carry out grafting. The waste PC and ABS-g-MA were melt-blended using a twin-screw extruder. The experiment showed that the grafting degree was affected by either reaction time or the loading of MA. The relative grafting degree increased with increasing reaction time at a constant loading of MA. Similarly, the relative

grafting degree increased with increasing loading of MA at a constant reaction time.Due to the lower impact strength of waste PC, the ABS-g-MA had to introduce to improve the impact strength. The impact strength increased due to the rubber components of ABS that toughened the waste PC materials. MA grafting ABS were added in order to eliminate repulsion between polar segments and nonpolar PC ones and at a certain PC/ABS-g-MA weight ratio, the domains of dispersed ABS formed a network.The morphology was so obtained that no change in the size of the dispersed domain of ABS upon adding maleic anhydride which referred no effects of maleic anhydride grafting upon the compatibility of PC/ABS blends. The unmodified ABS appeared as tightly packed while the modified ABS appeared to be loosed which wound up that MA boosted ABS.

This experiment was examined by *Wang etal.*[44], the effect of a chemical compatibilizers like Styrene-Butadiene-Glycidylmethacrylate (SBG) in the blends of recycled PC/ABS imparted from E-waste. The blending of the polymers and compatibilizers took place in a twin-screw extruder through melt blending.FTIR characterization exhibited increase in the ester and ether peaks, possibly due to the reaction between the hydroxyl groups present in the blend with the epoxy group residues in SBG.From the mechanical observations SBG was found to be efficiently compatibilized the recycled PC/ABS blends which resulted in enhancement of impact strength was found to be increased to 220% at 6% of SBG compatibilizers.Morphology study from SEM micrograph evidenced the reduction in ABS phase dispersion which concurred better compatibility.

Marie-Liseet al.[45] studied that recycled aged ABS does not match the impact strength of virgin ABS due to its polybutadiene degradation or presence of flame retardant (FR). So, this recycled ABS were blended with PC to form ABS/ PC blend to at least acquire the strength equivalent to pure ABS and within the range of co position of real waste electrical and electronic equipment (WEEE) deposit. To acquire optimal processability and composition, ABS/PC blends were made from virgin polymer.By doing morphological studies and charpy impact strength test. We can evaluate influence of extrusion temperature and PC content on blends. Experimental data shows that the impact strength if ABS/PC blends are higher when morphology is co -continuous or fibrillary like.They obtained a blend of virgin ABS/PC (70/30) with higher impact strength than neat ABS. But with

same composition this result is not obtained for recycled ABS blends with PC. So, to which achieve obtain blends rich in recycled ABS, compatibilization is necessary. So, recycled ABS/PC blends (70/30) compatibilized with 5% PP-g-MA for better result. But in presence of a FR or when subjected to a high residence time during injection, a compatibilizing agent has a limited efficiency.

Theprocessing and mechanical properties of PC/ABS blend were studied by *Liang et al.*[46]. Here To reduce batch to batch property variation in the blend product they added a high content of recycled PC in the PC/ABS blend. Recycled PC at a purity > 99 %, virgin PC with low molecular weight and ABS were blended. Replacing of virgin PC by recycled PC cause significant reduction of mechanical properties. The blend of virgin ABS with 5% HF-PC and 45% recycled PC blend form more brittle product. With adding 10% HF-PC to the blend recover mechanical properties to some extent but with further increase in the content shows no significant change. So, PC/ABS blend with 50 % virgin ABS, 10 % virgin PC with low molecular weight and 40 % recycled PC is an acceptable product with balanced processing and mechanical properties.

In this experiment paper *Azmanhassan et al.*[47]studied the different properties of ABS/PC blends like tensile, flexural, impact and creep with different weight content ratio. Emulsion grade, super high impact ABS resin with PC were melt blended in ratio 0:100, 20:80, 40:60, 60:40, 20:80, 100:0 in a co-rotation twin screw extruder at a speed r.p.m. With increasing of PC content in ABS/PC blend tensile property improve. Both the Young's modulus and tensile strength were increased with PC content. Even flexural strength and modulus show significant increase. Impact strength increases with PC content. With adding small amount of PC (20 wt %) to blend causes sudden drop in the impact strength. Neat PC showed highest value of creep resistance while ABS shows lowest value. ABS/PC blend ratio 40:60 showed optimum formulation of mechanical properties and cost.

The generation of morphology during various thermal processing of PC/ABS and the effect of viscosity ratio of the polymers present in the blend was experimented by *Barwinkleet al*.[48]. The blend was formed with 60 % of bisphenol-A-polycarbonate and 40 % of ABS copolymer prepares by emulsion polymerisation with SAN grafting. The blending was done with a co-rotating twin screw extruder.TEM observation exhibits that the morphology of the injection moulded specimen and other extrusion

compounded pellets were different. Injection moulded specimen formed morphology in the upper layer and cone. For the morphology obtained in the surface layer lamella morphology of SAN/ABS phase was observed. While as the SAN core represented a rough and randomly oriented (co-continuous) morphology.The molecular weight played a crucial role in the morphology formation. The SAN mol. wt didn't have much significance on the morphology formed in core. But the surface morphology was affected by the molecular weight of SAN due to the rise in molecular weight, which resulted increase in melt viscosity.

This investigation was done by *H.Suarezet al*.[49]on a comparison between extruder sheet of PC/ABS blend and injection moulding bar. The blends were made by melt mixing in laboratory extruder. At a suitable temperature i.e 260^0c the blending took place as excessive temperature cause degradation of ABS. the sheet specimens were 0.011 in thick and 2.5in wide. The injection moulded bars were converted to pallets using extrude. The moulded specimens were form in the dog bone shape (ASTM D 638) 7 Izod bar (ASTM D 256).The module for extruder sheet was significantly lower than that of injection moulded bar. The yield strength for extruded sheet is slightly lower for all composition than injection mouldedbar [50]. The moduli for ABS and PC differ about 43000psifor extruder sheet while for injection moulded bar it is half of the value. Impact strength of the blend decrease slightly until the PC composition reached 50 % with increase in PC content the toughness increased.

Eguiazabal et al.[50] executed the effects of reprocessing on the physical and chemical properties of the PC/ABS blends. The reprocessing of blend was done by injection moulding. In the course of reprocessing there is no significant change in PC and a little darkening was observed in ABS. The FTIR analysis showed the unaffected chemical structure of PC throughout reprocessing while in ABS oxidative degradation of butadiene occurred. During recycling of PC/ABS blend crosslinking observed as a result of which the reaction happened in the rubbery phase of ABS.The properties like modulus of elasticity and yield stress did not change by reprocessing. However, the tensile strength, the ductility and the impact resistance were affected by reprocessing. The significant changes in properties were observed after 2 processing cycles. The properties remained almost same up to 2 cycles. Then occurred a sharp decrease in the properties. The density and MFI values

were seen to be affected by reprocessing. The MFI value increased quickly after three processing cycles. So, the fluidity of the product was increased which led to the decrease in the molecular weightof the polymers.So, it was concluded that the reprocessing process affected the properties of PC/ABS blends significantly after 2-3 processing cycles.

CONCLUSIONS:

The papers examined the effect of different composition of PC/ABS blends on its mechanical, morphological and thermal properties. With increasing the amount of PC in the blend its mechanical properties like tensile strength, impact strength, modulus increased while with increase amount of ABS the processability of the blend increased. So, we observed PC/ABS 70/30 is the optimal composition of the blend. From various observations PC/Abs blend was found to be partially compatible. So, the incorporation of various compatibilizers like maleic anhydride grafted PP, EVA-g-MAH, MAH-g-ABS, and Amine functional SAN were reported. The compatibilizers effectively reduced the surface tension between PC and ABS and enhanced the compatibility resulting better physical properties. Several authors reported about effect of type of ABS with different rubber contents on the blend. Smaller rubber particle size exhibited better mechanical properties in the blend. As PC/ABS blend is highly flammable with addition of some fire retardant like Brominated epoxy resin, Brominated phosphate to the blend made it inflammable.It was noticed that Young's modulus increased symmetrically with higher amount of polycarbonate in the blend. HDT and vicat softening temperature also increased continuously between 0-50 wt % of PC. After this the HDT value increased abruptly.It was observed that 50 % of rubber in ABS is optimal proportion for various applications as the impact strength was at its highest point while yield strength and young's modulus were at adequate levels. From the observed data, 90 wt % PC resisted the highest stress and strain whereas 10 % ABS had no significant effect on processability and chemical resistance in the blend.

The study about recycled PC/ABS blend showed some significant properties and changes from the virgin blend. The recycled PC from WEEE was used in the blend the PC did not show any significant degradation in properties up to 3 recycling process. In 4^{th} cycle it showed a small change in impact strength. Comprehensive mechanical properties were obtained at 20 % of recycled ABS In the blend. For most of the studies 40 wt %

of recycled PC, 10wt% of high flow virgin PC and 50wt% of virgin ABS was found to be optimal for reasonable properties analysis. Incorporation of various compatibilizers increased the compatibility of the blend and made them efficiently compatible and increased their physical properties. However, the thermal, mechanical and morphological properties of recycled PC/ABS blend lacked behind virgin PC/ABS blend but found economically beneficial.

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