Volume 5, Special Issue, June 2018 ISSN: 2348-8565 (Online)

International Journal of Modern Engineering and Research Technology

Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

National Conference on
Advances in Mechanical Engineering and Nanotechnology (AMENT2018)
29-30 June, 2018
Organized by
Department of Mechanical Engineering, University College of Engineering (A),
Osmania University, Hyderabad, TS, India

Recent Trends in Abs-Calcium Carbonate Polymer Composite Processing: A Review

S. Sreenivasulu
Department of Mechanical Engineering
Sreenidhi Institute of Science and Technology
Hyderabad (T.S.) [INDIA]
Email: srinivas019@gmail.com

A. Chenna Kesava Reddy
Professor
Department of Mechanical Engineering
JNTU College of Engineering
Hyderabad (T.S.) [INDIA]

ABSTRACT

Polymer composites are finding it increasing various engineering applications such as automobile, aerospace and others applications due to its good mechanical and processing properties. The ABS -Calcium Carbonate composite samples were prepared in a twin screw extruder followed by injection molding. Recently many researchers have dealt with ABS-Calcium Carbonate polymer composite .the specific objective of this paper is to review the collection of literature available on ABS-Calcium Carbonate composite. Recently ABS-Calcium Carbonate composite is preferable in many industries to reduce the manufacturing cost. Normally input process parameters considered for experimental investigations are tensile, impact and bending strength and chemical composition of the test specimen and the output responses are stiffness, hardness, flexural modulus and micro structure .Based on the literature review an investigation is essential to improve the quality of the polymeric composite to reduce the time & cost. The authors found that input process parameters play vital role in quality and efficiency of the polymeric composite

Keywords:— *polymeric composite, input process parameters, output responses*

I. INTRODUCTION

Nowadays polymers and its composites are commonly used in such as 3D printing, automotive industries etc. To improve the properties the inorganic and organic fillers of micro and Nano-size fillers are used. ABS (Acrylonitre-butadiene-styrene) has a variety of applications include office and domestic equipment, safety helmets, pipes and fitting, automotive exterior and interior trim components, medical devices for blood access. ABS is superior for its hardness, ductile, toughness and electrical insulation properties. Acrylonitrile gives good heat stability and chemical resistance, butadiene

gives impact strength and toughness and the styrene give easiness of processing. Calcium Carbonate consists of carbon, calcium and oxygen. It is odorless and tasteless. Calcium Carbonate is mostly used mineral in paper, paints, plastics and coating industries both as filler and due to its white color as a coating pigment. Calcium Carbonate is largely used in construction industry both as a building material and ingredient cement. ABS is generally filled with rigid inorganic fillers such as Calcium Carbonate, talcum powder, glass beads, in order to enhance its stiffness, strength and reduce the production cost. The bond strength between the filler and polymer matrix is important factor in determining the properties of the composite. The coupling agents are used to enhance the compatibility of polymer and the filler. Coupling agents are bi-functional molecules which bonds chemically both the filler surface and polymer, improving the bond strength between filler and matrix. The addition of fillers into ABS can give an opportunity to expand its varies applications and compete with low price of plastics. In this paper more studies are concentrated on Calcium Carbonate filler.

Table.1. The Characteristics of ABS and Calcium Carbonate

S.No	Property	ABS	Calcium Carbon-ate
1.	Full name	Acrylonitrile Butadiene Styrene	Calcium Carbon-ate
2.	Chemical formula	$(C_8H_8 \cdot C_4H_6 \cdot C_3H_3N)_n$	Calcium Carbon-ate
3.	Density	1.060–1.080 g·cm−3	2.93 g/cm3
4.	Melting Tempera-ture	200°C (392°F)	825°C(1517°F)
5.	Solubility in water	Insoluble in water	insoluble in water and in alcohol

The Characteristics of ABS and Calcium Carbonate are illustrated in Table 1. There are many researchers worked in the combination of ABS-Calcium Carbonate with different directions and there research finding are given below.

II. LITERATURE REVIEW

CY.Tang et al. (2002) studied the effect of Calcium Carbonate combine with acrylonitre-butadiene-styrene co-polymer (ABS). the main objective of this study is to evaluate the tensile strength, tensile fracture stress, impact strength and bending strength with respect to weight fraction (ϕ).the output response are stiffness and bending strength. The molten ABS and Calcium Carbonate particles are mixed in a twin screw extruder at the temperature 70-230°C, the compositions by fillers 0, 10, 20, 30, 40, 50%. finally the specimens are molded in injection molding machine. The tensile properties are measured by Instro material testing machine (M4206). The Vicat softening temperature is measured using HDTVICAT softening point apparatus. The authors concluded that addition of Calcium Carbonate with ABS will increase the Vicat softening temperature (TV), young's modulus, impact strength of the composite.

Ji-Zhaoliang et al. (2002) investigate the effect of filler content and Rheological behavior of nano meter Calcium Carbonate filled acrylonitrile-butadiene-styrene (ABS). The input parameters are temperature, shear rare and filler volume fraction. The output responses are melt shear viscosity, extinction viscosity and wall shear stress. The resin and fillers were blended in a twin screw extruder and granulated to produce the composite. Twin-bore capillary rheometer is used for testing. The author concluded that the melt shear viscosity increase nonlinearly with increase of the filler concentration when wall shear stress was constant.

C.Y. Tang, J.Z. Liang (2003) studied the melt flow behavior of abs/Calcium Carbonate composite material. The main objective of this study is to explore the effects of filler size, content and surface treatment on the melt flow behavior of ABS/Calcium Carbonate composite. The molten ABS and Calcium Carbonate are mixed in twin screw extruder with length/ diameter ratio 25:1, weight fractions(ϕ) of fillers were 0, 10, 20, 30, 40, 50%. A Melt Flow Indexer is used for measuring the MFR. The authors suggested that MFR increased linearly with increase in temperature and was a power law function of load. Furthermore MFR decreases basically with addition of filler content (ϕ).

L.Jiang et.al.(2004) investigated the effect of nano sized and micro sized Calcium Carbonate with acrylonitrile- butadiene-styrene (ABS). The objective is to explore the properties of higher modulus, tensile and impact strength of microsize(MCC) and nano size precipitated Calcium Carbonate (NPCC) combined with ABS. The output responses are impact and tensile strength. A conical twin screw extruder is used to disperse NPCC and MCC into ABS homogeneously. The composites are vacuum dried and extruded the second time to achieve better filler dispersion. The Injection molding machine is used for preparation of standard tensile and Izod impact test samples. SEM micrographs shows that NPCC particles were distributed smaller sizes than MCC in the ABS Matrix. The authors concluded that NPCC/ABS is superior to MCC/ABS w.r.t to impact & tensile strength.

JI-ZhaoLiang et. al.(2005) studied the mechanical properties of ABS-Composite filled with Hollow glass beads. Three types of hollow glass beads with different distribution and sizes are used as fillers. HGB1 had a small diameter and larger distribution, HGB2 had a medium distribution and larger diameter and HGB3 had a narrow distribution in medium size. After mixing at room temperature molten ABS with HGB are compounded in twin screw extruder and the volume fractions of the fillers were 0, 5, 10, 15, 20%. respectively. specimens are molded in injection molding machine and tested for tensile, impact and flexural strength. The author concluded that addition of hollow glass bead to the ABS increases its stiffness and flexural strength. The tensile fraction strength and tensile yield strength decreased with increase of volume fraction of the beads.

Wen-yiwang et.al. (2007) investigate the mechanical properties of nanoCalcium Carbonate-ABS composites. The samples are prepared by melting blend with single screw extruder. Impact strength of nano composite measured by Charpy impact testing machine and universal testing machine is used for testing flexural and tensile properties. The output parameters are flexural modulus, impact strength and tensile strength. The authors reported that the flexural modulus of the composite is increases by adding Nano Calcium Carbonate and tensile strength of the nano composite decreases by adding Calcium Carbonate nano particles

Aimin Zhang et.al (2010) illustrated the mechanical and flow properties of ABS/ PMMA/nano Calcium Carbonate composites. ABS resin, PMMA resin and Nano Calcium Carbonate are dried in an air circulated oven at 800c for 12h to remove all the moisture. The blending is carried in a twin screw extruder. The specimens are prepared on a injection molding machine. The composite properties are analyzed by Izod impact test, tensile test, melt flow Index (MFI) test and field emission scanning electron microscopy (FESEM). The authors concluded that the tensile yield

strength, Izod impact strength decreases slightly with addition of nanoCalcium Carbonate. The MFI of the composite increases linearly with the increases of test temperature.

Xiaojuanbai et.al. (2012) investigate the reprocessing effect on ABS/Calcium Carbonate composites. The Fourier transform infrared spectroscopy (FTIR) and gel permeation chromatography(GPC) are used for analyzing. ABS with 0-30% of Calcium Carbonate composition specimens are prepared by twin screw extruder and the part of pallets was made into samples by an injection machine for mechanical testing. The author concluded that with the number of processing cycles is increased the impact strength is reduced at low content of Calcium Carbonate(less than 10 and relatively the tensile properties are stable.

Sanaz Abdolmohammadi et.al.(2012) study the thermal and mechanical properties of polycaprolactone-chitosan blend by calcium nano particles. The main objective is to evaluate the tensile strength and elongation at break. The components were prepared using melt blending technique. The output responses considered are tensile modulus and tensile strength. It is concluded that thermal stability of the composite is increased by adding nano-Calcium Carbonate.

Azman Hassan et.al(2012) illustrated the effect of particle size and surface treatment of Ground Calcium Carbonate (GCC) on the thermal and mechanical properties of ABS/PVC composite. ABS is dried in hopper for 24 hr prior to compounding, the components are blended in twin screw extruder. The extruded material were injection molded using special mould for tensile, flexural and Izod impact testing. The author concluded that the flexural modulus of GCC filled ABS/ PVC composite increases while flexural strength decreased. The Izod strength gives that the addition of GCC into ABS/PVC (80:20) blends resulted significance decrease of composite impact strength.

J.Sudeepan et.al. (2014) investigate the tribological properties of ABS/Calcium Carbonate polymer composite using taguchi method. The input process parameters are friction and wear depth. The output response are filler content, normal load and sliding speed. Friction and wear experiment are conducted in multi tribi-tester using roller configuration dry sliding condition for 300 seconds with filler content, normal load & speed. Taguchi analysis is used for optimization of friction and wear parameters. The authors conclude that ANNOVA under normal load is the most important factor affecting friction coefficient.

Liang wang et.al. (2014) demonstrated the effect of Calcium Carbonate on thermal properties of ABS/Calcium Carbonate Composite. Thermo gravimetric analysis (TGA) and differential scanning calorimetry (DSC) are used to analyze the composite. The authors concluded that the effect of microCalcium Carbonate on the degradation of ABS composite is similar to nanoCalcium Carbonate. In the presence of nitrogen the max. Weight loss rate of composite gradually decreased with increase in Calcium Carbonate.

Sudeepan Jayapalan et.al.(2014) studied the tribological behavior of Calcium Carbonate/ABS composite by grey relational analysis. The input parameters are normal load, filler content and sliding speed. The output response are co-efficient of friction (COF) and specific wear rate. Experiments are done on muti-tribo tester based on L27 orthogonal array (OA). ANOVA is also used to find most influential factor on tribological properties. The authors identified that the conformation

test shows that grey relational grade increased about 72.56% from initial to optimum conditions i.e addition of micro sized Calcium Carbonate at right amount of design parameters, the tribological properties are also improved.

Pham Son Minh et.al (2014) demonstrate the effect of Calcium Carbonate on the warpage of injection molding parts. Three types of material ABS, PP and PVC are selected for observing the influence of volume shrinkage ratio on the warpage. Different weight ratios of Calcium Carbonate (10%, 20%, 30% and 40%) additives are mixed with PP and molded. For simulation mold flow software is used for building runner, system, melt cavity and cooling system. The authors observed that the volumetric shrinkage ratio of the plastic has strong influence on the warpage with thickness 1.0mm, 1.15mm and 2.0mm .the result shows that more the Calcium Carbonate addition the lesser is the part wrapped.

J.Z.liang. et. al (2014) studied the sound transmission losses for polymer/inorganic particle composite. Three samples PP/nano Calcium Carbonate, ABS/Calcium Carbonate and PVC/HGB Composites are taken into consideration. Experiments are conducted on simplified sound transmission loss testing machine. The author concluded that under the same sound frequency, the transmission loss of PVC/HGB composites were higher than those of ABS/Calcium Carbonate and PP/nanoCalcium Carbonate composite.

Omid Momen.et.al.(2015) investigated the effect of ABS and nano particles of Calcium Carbonate on Isotactic polypropylene(PP). The objective is to explore the mechanical properties, phase morphology and deformation behavior under impact loading. Specimens are prepared by melt mixing the components in internal mixer and hot press machine. The output response is Izod impact strength and morphological observations. The authors concluded that the impact toughness of ternary PP/ABS/Calcium Carbonate nano composite was larger than PP/Calcium Carbonate and compatibilized PP/ABS Blends.

Jianjun Zhang et.al(2015) studied the high impact toughness ABS/Calcium Carbonate nano composite prepared by pressure Induced Flow(PIF) Moulding.The ABS and surface treated Calcium Carbonate nano particles were blended in Hooke torque rheometer. After PIF moulding there is a large improvement in mechanical properties of ABS and nano composites. The author conclude that by processing pressure Induced Flow Moulding the impact toughness is increases by 133% and highest tensile toughness is increased by 676%.

A.E. Sahin et.al (2015) investigated solid particle erosion and thermo mechanical behavior of ABS/PA6 composite reinforced with Calcium Carbonate particles and Short glass fibers(SGF). The Calcium Carbonate particles and SGF are reinforced in ABS/ PA6 composite at different weight ratio(0, 10, 30, 15/15 wt.%).Specimens are prepared by twin screw extruder and injection moulding machine. Dynamic Mechanical Analysis (DMA) is used for investigating thermo mechanical properties. The authors concluded that addition of SGF and Calcium Carbonate reinforcement increases loss modulus and storage modulus of ABS/PA6 polymer. ABS/PA6 is eroded more at particle impingement angle of 30° than 45°.

G.S. Ananthapadmanabha. et.al (2016) demonstrated thermal properties of acrylonitrile-butadiene-styrene composite. The main objective of this study is to study the effect of fillers with different shape on the properties like decomposition

temperature, HDS of ABS. Specimens composition is prepared by twin screw extruder carry at temp 175-220°C, test specimen are prepared by injection molding. Thermal properties are studied by thermo gravimetric analysis (TGA), Differential scanning calorimeter (DSC) and heat deflection temperature (HDT). It is concluded that thermal properties showed no significant change with respect to HDT and glass temperature.

Vikrant Deshpande et.al (2017) investigate the effect of aspect ratio (shape) of the filler on the properties of ABS polymer. ABS/ Talc and ABS/Calcium Carbonate composites were prepared in a twin screw extruder with titanate coupling agent. Test specimens are prepared by injection molding for further comparison and evaluation studies. Thermal properties are carries out in DSC. Flexural properties were studied by three point bending machine. Finally the properties of ABS/talc and ABS/Calcium Carbonate composites were compared with unfilled ABS processed without any filler. The author conclude that higher aspect ratio filler like talc is more effective than low aspect ratio filler like Calcium Carbonate.

III. CONCLUSIONS

ABS-Calcium Carbonate polymeric composite is one of the most significant polymeric composite. It produces high impact strength, hardness, toughness and more economical components. Based on the review of varies literature papers on ABS-Calcium Carbonate polymer composite the following points are concluded Vicat softening temperature (Tv) will increased with the addition of weight fraction, young's modulus of composite.

- Nano precipitated Calcium Carbonate (NPCC)/ABS composition have better tensile and impact strength of micro size Calcium Carbonate(MCC)/ABS composite
- Experiments are conducted on nano meter Calcium Carbonate filled ABS composite and show that sear flow did not obey the power law conditions
- During reprocessing ABS/Calcium Carbonate composite the impact strength is reduced with increase in reprocessing cycles at low levels of Calcium Carbonate(less than 10%)
- By adding nanoCalcium Carbonate particles ABS matrix, the tensile strength of the composite is decreasing and flexural modulus of the composite is increasing.
- Melt Flow Rate(MFR) of the ABS/ Calcium Carbonate composite is increases linearly with increase in temperature and MFR decreases with addition of filler content
- By using pressure induced flow moulding to the ABS/Calcium Carbonate nano composite the highest tensile toughness increases by 676% and impact toughness increases by 133%.
- By addition of any filler to the ABS, there is no change in the decomposition temperature of the polymer
- In ABS composite the higher aspect ratio filler (talc) is more effective than low aspect ratio filler (Calcium Carbonate).

Based on the review work the authors initiate tensile strength, impact Strength, Melt Flow Rate, Vicat softening temperature of the ABS-Calcium Carbonate polymeric composite. The authors identified that, there is a need of research in ABS-Calcium Carbonate composite to improve the quality of the output based on the input

process parameters. This review work is very precious for the researchers to develop the ABS-Calcium Carbonate polymeric composite specimen is essential for the modern development in the engineering industry.

REFERENCES

[1] C.Y Tang and L.Cchan, J.Z.liang, K.W.E.Cheng, T.C Wong" mechanical and thermal properties of ABS- Calcium Carbonate Composites" Journal of Reinforced Plastics and Composites, vol.21, no.15/2002.

[2] Ji-zhalliang "Meltrheology of nanometer Calcium Carbonate filled acrylonitrile-butadiane- styrene(ABS) copolymer composite during capillary extrusion" polyninst 51:1473-1478 (2002).

[3] C.Y. Tang, J.Z. Liang. "A study of the melt flow behavior of ABS/ Calcium Carbonate composites" Journal of Materials Processing Technology 138 (2003) 408–410.

[4] L.Jiang, Y.C.Lam, K.C.Tam, T.Hchua, G.w.sim, L.s.Amg" strengthing acrylonitrile-butadiane-styrene(ABS) with nanosize and micro sized Calcium Carbonate"polymer 46(2005)243-252,2005.

[5] JI-zhao liang" Mechanical properties of hollow glass bead filled ABS Composites" Journal of Thermoplastic composite material, Volume: 18 issue: 5, 407-416(2005).

[6] Wen-yi wang, Guo-quan wang, xiao-feizeng, hishao, jian-fengchen" preparation & properties of Nano-Calcium Carbonate/ABS composites" Journal of applied polymer science, vol. no 107, 3609-3614(2008)

[7] Aimin Zhang,Guoqun Zhao,Yanjin Guan, Guowen Chen" Study on Mechanical and Flow Properties of Acrylonitrile- butadiene-styrene/Poly (methyl methacrylate)/Nano-Calcium Carbonate Composites" September 2010, Polymer Composites 31 (9):1593 – 1602.

[8] Sanaz Abdolmohammadi, Samira Siyamak, Nor Azowa Ibrahim,Wan Md Zin Wan Yunus Mohamad Zaki Ab Rahman, Susan Azizi and Asma Fatehi " Enhancement of Mechanical and Thermal Properties of Polycaprolactone/Chitosan Blend by Calcium Carbonate Nanoparticles" International Journal of Molecular Sciences i. 2012, 13, 4508-4522.

[9] Xiao Jvanbai, Zhe Wv, NavFeng "Degradation of ABS/Calcium Carbonate composite during reprocessing" Advanced Material Research ISSN:1662-8985,VOL-455-456 PP845-850(2012).

[10] Azman Hassan, Abozar Akbari, Ngoo Kea Hing and Chantara Thevy Ratnam," Mechanical and Thermal Properties of ABS/PVC Composites: Effect of Particles Size and Surface Treatment of Ground Calcium Carbonate" Polymer- Plastics Technology and Engineering, 51: 473 –479, 2012.

[11] Sudeepan Jayapalan, Kaushik Kumar, Prasanta Sahoo "Study of Tribological Behavior of ABS/ Calcium Carbonate composite using Grey Relational Analysis" Procedia Meterials Science 6(2014)682-691.

[12] A.E. Sahin, S.Y lmaz, T.Y lmaz,

T.Sinmazçelik," Thermo mechanical and Solid Particle Erosion Behavior of Calcium Carbonate and SGF (Short Glass Fibre) Reinforced ABS/ PA6 Composites" Proceedings of the 4th International Congress APMAS2014, April 24-27, 2014, Fethiye, Turkey.

[13] Pham Son Minh, Phan The Nhan "Effect of Calcium Carbonate Additive on The Warpage of Injection Molding Part" Universal Journal of Mechanical Engineering 2 (9): 280-286, 2014.

[14] J.Sudeepam, K.Kumar, T.K Barman "Study the Trobological Properties of ABS/Calcium Carbonate polymer composites using Taguchi Method' IOSR Journal of Mechanical & Civil engineering (IOSR-JMCE)e-ISSN:2298-1684 P-ISSN:2320-334 X,PP 38- 42(2014).

[15] XiaoJuanbai, Lingwang "Effect of Calcium Carbonate on the thermal properties of acrylonitrile- butadiane-styrene(ABS)/Calcium Carbonate composite" advance material research vols. 834-836(2014) PP 276-280.

[16] Omid Momen, Majid Mehrabi-MAZIDI, Neda Jahngiri "Isotactic polypropylene (PP) modified by ABS and Calcium Carbonate nanoparticles: effect of composition and compatibilization on the phase morphology, mechanical properties and fracture behavior" Polym. Bull. (2015) 72:2757–2782.

[17] J.Z.liang" Prediction of Sound Transmission Losses for Polymer/ Inorganic Particle Composites" June 2014, Polymer Composites 36 (11):2059-2065, 2015.

[18] Jianjun Zhang, Junli Zhao, Kun Li, Sen Zhang, Yu Ma" High impact toughness ABS/Calcium Carbonatenanocomposites prepared through pressure induced flow moulding" ISSN: 1662-7482, Vols. 799-800, pp 175-178.2015

[19] G.S. Ananthapadmanabha, Vikrant V. Deshpande" Thermal Properties of Acrylonitrile Butadiene Styrene Composites" Indian Journal of Advances in Chemical Science S1 (2016) 279-282.

[20] G. S. Ananthapadmanabha, Vikrant Deshpande," Influence of aspect ratio of fillers on the properties of acrylonitrile butadiene styrene composites" Wiley Periodicals, Inc. J. Appl. Polym. Sci. 2018, 135, 46023.

* * * * *