Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 6, Issue 4; April-June, 2019, pp. 233-236

http://www.krishisanskriti.org/Publication.html

EFFECT OF FILLER NANO ZIRCONIUM OXIDE ON THERMAL STABILITY OF NYLON 6

Pankaj Srivastava[1] and Smita Mathur[2]

[1,2]CIPET: IPT LUCKNOW
E-mail: [1]panku.rbl2007@yahoo.com, [2]smitamathurcipet@gmail.com

Abstract—*A nano composites has a matrix and a reinforcing component. In case of polymer nanocomposites, matrix is polymer and reinforcing component is which has at least size of range of 1-100 nanometers. Polymer Nanocomposites has high strength , easily processable and low cost material, so it takes much attention to all. Here we study about the effects of nano zirconium oxide on the thermal stability of Nylon-6. Nylon-6 is an Engineering thermoplastics material that has balanced thermal and mechanical properties. Zirconium oxide is white crystalline oxide of zirconium. It has melting point 2715C, pure zirconium oxide has three phase, it is mono clinic below 1170C, tetragonal between 1170C and 2370C and has cubic structure above 2370C. Here firstly Nylon-6 and nano zirconium oxide nanocomposites were prepared through melt mixing method with help of Twin Screw Extruder. The loading of nano scaled zirconium oxide were .5%, 1% ,1.5% and 2% in Nylon-6. After this the specimen were prepared. The nanocomposites were characterized by Scanning electron microscope and ThermogravimetricAnalyser.That gave amazing results.These properties may be useful for various engineering sectors*
KEYWORDS: Nylon6, Zirconium oxide, Nanocomposite

I. INTRODUCTION

NYLON-6 is mostly used in Engineering sector due to its properties such as good mechanical properties. However, its water absorption restrict its applications and low heat distortion temperature. When we added the inorganic filler in Nylon 6, it improves the mechanical properties such as toughness etc.

Zirconium oxide is a inorganic filler used as reinforcing agent in Nylon-6 because of its high hardness, high fracture toughness, low thermal conductivity, wear resistance and chemical inertness.

Zirconium di oxide is a oxide of zirconium. Its common name is zirconia. It is white crystalline. Its natural form is mineral baddeleyite has monoclinic structure. Baddeleyite is a refractory material, has range transparent to translucent having high refractive index. It has three phases structure as monoclinic below 1170c, as tetragonal between 1170c and 2370c and as cubic above 2370c. It is chemically unreactive. but slowly attacked by concentrated hydrofluoric acid and sulphuric acid. When Zirconia is blended with oxides such as magnesium oxide ,yattrium oxide, the tetragonal and cubic phases are stabilised.

When yattria is added in small amount in it, the phase change is eliminated and resulting material gets superior thermal, mechanical and electrical properties.

It is used to make high performance knives and scissors .because it has hardness about to as scale of moh`s scale 9 on which diamond`s hardness value is 10. It is used by sea drivers in the form of extremely fine and sharp blades and it is not corroded in marine environment. This is harder than steels, and also ceramics are not rusted. Its implement is used to cut a such tough material such as Kevlar in bullet proof jacket. It is used to make golf club head since having great toughnees and hardness. There is industrial applications such as the components of motor engine, cutting tools that works at high speed, linings (heat resistant) in furnaces, containers for keeping molten metals, and heat shields (for space vehicles).A nano inorganic filler is used because properties are improved more than conventional sized filler. Its concentration is used in the range of 0% to 5%. Many inorganic ceramic fillers such as Silicon di oxide , Titanium di oxide has been used to improve mechanical properties of Nylon 6. This paper shows that nylon 6 is preheated and compounded with nano zirconium oxide with the help of twin screw extruder and Nylon 6 / Nano zirconium oxide composite is produced. The characterization is performed with the help of Scanning electron microscope and Thermal gravimetric analyser.

II. MATERIALS USED

Here as a Reinforcement Nano Zirconium Oxide was used. It was purchased from Nano research Lab Jamshedpur Jharkhand and as a matrix material Nylon-6 was used. It is of Grade- M28RC and Manufacturered by Gujrat State Fertilizer and Chemicals ltd, India For this it was procured from Siddh Trading Company, Near Mohan hotel charbagh, Lucknow.

The general properties of Nano Zirconium Oxide are mentioned at following

Physical Data Of NanoZirconiumoxide

1. Form – Powder
2. Color – white
3. Density at 20 C- 5.89gm/cm3
4. Melting Point – 2715C
5. Particle size – 30nm -50nm
6. Odour – Odourless
7. Solubility in water – Insoluble

III. PREPARATION OF COMPOSITE AND SPECIMENS

The composites of Nylon-6/Nano Zirconium oxide were prepared by co rotating twin screw extruder that is made by SPECIFIC ENGINEERING & AUTOMATES(India) in processing laboratory at Higher learning center, CIPET,(Lucknow).Its screw has L: D ratio 40:1 and screw diameter 21 mm. The temperature range and srcew RPM that was used 180-240°C and 60 rpm. Since Nylon-6 is a hygroscopic material so before compounding it was pre-heated at 85 °C in oven for 3 hours to make moisture free. Zirconium oxide was also pre-heated to remove moisture, it is necessary to make samples free from voids. Five batches of untreated composites were prepared as shown in table 1

Table: 1- Batch Composition

BATCH	COMPOSITION
PA6N	Nylon-6 + Nano zirconium oxide 0 Wt%
PA6Z0.5	Nylon-6 + Nano zirconium oxide 0.5 Wt%
PA6Z1	Nylon-6 + Nano zirconium oxide 1.0 Wt%
PA6Z1.5	Nylon-6 + Nano zirconium oxide 1.5 Wt%
PA6Z2.0	Nylon-6 + Nano zirconium oxide 2.0 Wt%

At first compounded pallets were predried at 80 C in oven. The sheets were prepared with the help of compression moulding machine and compression mould.. The compression moulding machines was at CIPET HLC, Lucknow and With the help of contour cutter and replica the specimen were prepared.

IV. CHARACTERIZATION

Thermal stability of Nylon 6/nano zirconium oxide composite was find out by using Thermogravimetric Analyser, which is made of Perkin Elmer (Pyris 1 TGA).This test was carried out under N_2 atmosphere in the temperature range 50-800°C. A heating rate of 20 °C/min was used and sample of mass of 5.0 ± 0.5 mg was used. The surface morphology was find out by using a scanning electron microscope which is made of (JEOL- JCM6000PLUS).This test was carried out under an acceleration voltage of 15 kV. Samples were holded in aluminium stubs and samples were sputter-coated with palladium and gold (10 nm).It was done by using a sputter coater (DII-29030SCTR Smart Coater) at for 120 s and at 10-12 mA current.

V. RESULTS AND DISCUSSION

Surface Characterization of sample

The scanning microscopy images of Nylon 6/nano zirconium oxide composite and in the presence of K 46 at different magnifications are shown in Figure 1 (a-b). Neat nylon 6 has a smooth texture in Figure 1(a) but in the SEM images of Nylon 6/nano zirconium oxide composite, spherical microballoons has not be seen clearly since zirconium oxide particles has dimensions of 30nm- 50nm that are not visible in 200 micrometer magnification of SEM in figure 1(b).

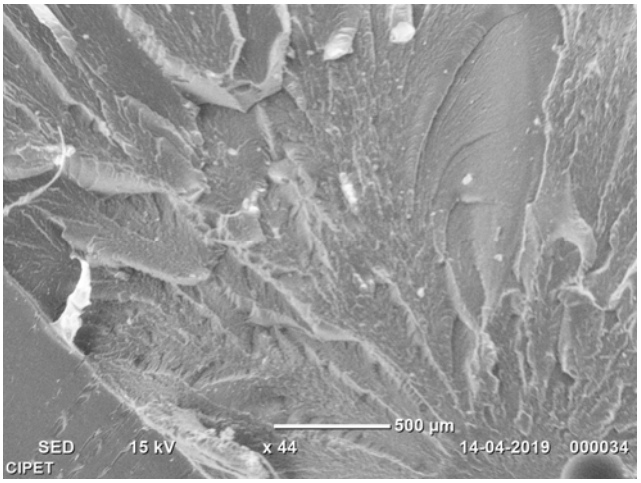

Fig.1(a) SEM image of Neat Nylon 6

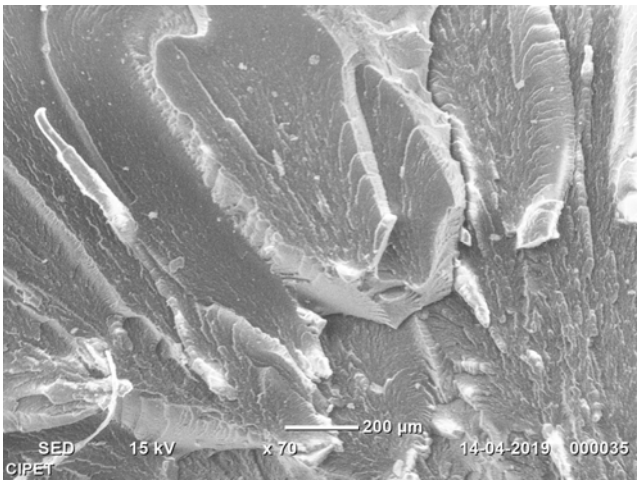

Fig1(b) SEM image of Nylon 6/nano zirconium oxide composite

Thermal Characterization

Thermogravimetric traces of neat Nylon 6 and Nylon 6/nano zirconium oxide composites are presented in Figure 2(a)-2(e).. All the specimens has a degradation profile of single step. Here in all traces there have been no change in thermal stability of neat Nylon 6 and of Nylon 6/nano zirconium oxide composite.

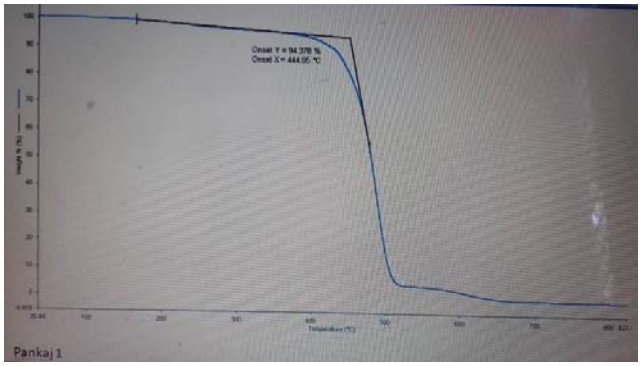

Fig.2(a) TGA image of Neat Nylon 6

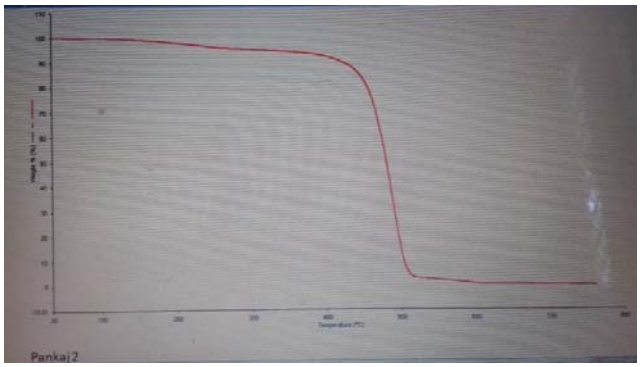

Fig2(b) TGA image of Nylon 6/nano zirconium oxide composite (PA6Z0.5)

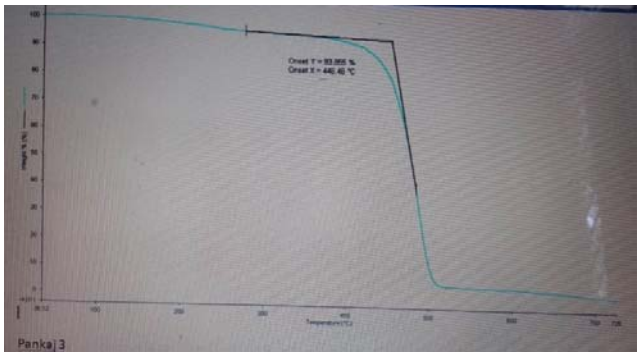

Fig2(c) TGA image of Nylon 6/nano zirconium oxide composite (PA6Z1.0)

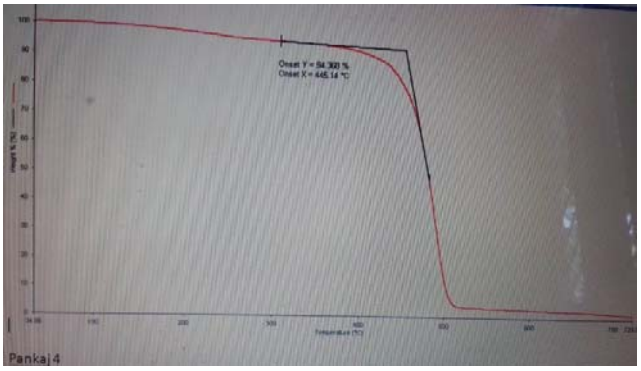

Fig2(d) TGA image of Nylon 6/nano zirconium oxide composite (PA6Z1.5)

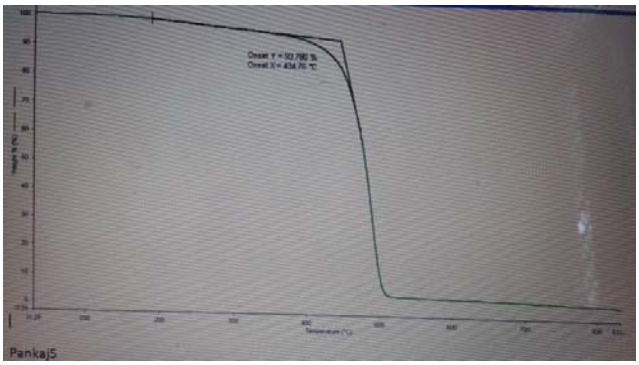

Fig2(e) TGA image of Nylon 6/nano zirconium oxide composite (PA6Z2.0)

VI. CONCLUSION

The thermal stability of nylon 6 nanocomposites has not been increased as shown in TGA traces results. So it may be possible that nano zirconium oxide are be not combatible with Nylon 6. Since the size of nano zirconium oxide is 30 nm - 50nm, so it has not been clearly visible in SEM analysis.

VII. ACKNOWLEDGEMENT

The author is acknowledged to Central Institute of Plastics Engineering & Technology, Lucknow. This institute hasall the necessary facilities for doing this research work.

REFERENCES

[1] Lathakumari, G. H. Du,W.Z. Li, S.K. Sexana, D.Z.Wang "Synthesis, microstructure and optical characterization of zirconium oxide nanostructures "Ceramic International 35 (2009) 2401-2408.

[2] Raquel Couto de AzevedoGoncalvesMota, Emerson Oliverira da Silva, Livia Rodrigues de Menezes "Effect of the Addiction of Metal Oxide Nanoparticles on the Physical, Chemical and Thermal Properties of PVA Based Nanocomposites" Materials Sciences and Applications,2018, 9, 473-488.

[3] M.Taheri, L.Maleknia, N. Alizadehghamsari, A. Almasian and GH.chizarifard "Effect Of ZrO2 Nanoparticles A Mordant of Properties of wool with thyme: dyeing, flammability and Antibacterial" Oriental Journal of Chemistry 155N-2015 ,Vol 31,No(1): Pg 85-96
[4] Paul G. Galanty, " Nylon 6", Polymer Data Hand Book, 1999
[5] Survasarathi Bose, P.A. Mahanwar "Effect of Particle Size on Properties of Nylon 6 " Journal of Mineral and Materials Characterization and Engineering, V 3. No.1,pp23-31, 2004
[6] Ihab N.S., Hassanen K. A., Ai N.A."Assessment of zirconium oxide nano-fillers incorporation and silanation on impact, tensile strength and color alteration of heat polymerized acrylic resin" J Bagh College Dentistry vol. 24(sp. Issue 2), 2012
[7] Vijayak. Rangari, Moh. Y. shaik, Hassan Mahfuz, Shaikjeelani "Fabrication and Characterization of high strength nylon 6 /Si3N4 polymer " Materials science and Engineering A 500 (2009) 92-97
[8] Ajaykumar Amin , BhaskarOza "Effect of Untreated Wollastonite on Mechanical Properties of Nylon6 " International Journal on Recent and Innovation Trends in computing and Communication, July 2015 4714-4718.
[9] Mohammad M.hasan, Yuaxin Zhou, Hassan Mahfuz, ShaikJeelanii, "Effect of Sio2 nanoparticle on thermal and tensile behaviour of Nylon 6" Material science and Engineering A 429(2006)181-188.
[10] ShimaShayestehfar, RaminKhajavi "Phiysical and Mechanical Properties Of Nylon-6/ Titanium dioxide Micro and Nano-Comosite Multifilament Yarns" Journal of Engineered Fibers and Fabrics Volume 9, Issue 3- 2014