International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 2, ISSN No. 2455-2143, Pages 494-497
Published Online June 2020 in IJEAST (http://www.ijeast.com)

THERMOPLASTIC MATERIALS AS PROMISING MATERIALS IN WELDING TECHNOLOGY-A REVIEW

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***Abstract*- It is known that plastics (thermoplastic materials) are replacing conventional materials such as steels and cast irons. Replacing conventional materials such as steel and cast irons by thermoplastic materials results in weight saving of the product. They are found in many industries such as automotive, aerospace, electronics etc. Among all types of polymeric materials only thermoplastic materials are weld-able and having the ability to be reshaped after heating. Similar and dissimilar thermoplastic materials can be easily welded as it has good physical and mechanical properties. It is very important to know the properties of various thermoplastic materials because by knowing the properties of thermoplastic materials one can select the correct materials for particular applications. This review paper presents the important properties and the fields of use of the more commonly used thermoplastic materials, which are easily weld-able like (polyethylene, polypropylene, polyamide, poly-methyl methacrylate, polycarbonates, Acrylonitrile Butadiene Styrene).**

Keyword- **Thermoplastic materials, Properties, Welding**

I. INTRODUCTION

Plastics are also called as polymers. Plastic is a one type of material and it is built from simple units called monomers through a process called polymerization. Plastics are made from crude oil, as the process of making plastics from crude oil involves different steps. It is soft, low-density material and having the property that, it is hammered into different shapes without fracture or break.

They can be processed any number of times. By replacing conventional materials by plastics, we can reduce the weight of the components up to ten times lighter than metals.

Plastics are classified into two types: thermoplastics and thermosetting plastics. Thermoplastics are melt-able in nature, i.e., they soften on heating and harden upon cooling. Thermoplastics include, polyethylene (low-density and high-density), polystyrene, PVC, polypropylene, polycarbonates, etc. These materials are used in various industries such as automotive, aerospace, electrical and electronic industries. A thermosetting polymer is a material that becomes permanently hard when heated, and do not soften upon subsequent heating. Thermosetting plastics include phenol formaldehyde, epoxy, polyester etc. These polymers are used for making toys, combs, hoses, electric insulation, etc.

Thermoplastics can be easily welded. Similar or dissimilar thermoplastic materials can be welded. The joint strength is equal or greater than the strength of the base materials. Sorensen et al. (2001) studied welding thermoplastics with friction stir welding process.

This review paper presents the important properties and uses, of the currently used thermoplastics in welding technology.

II. PROPERTIES AND FIELDS OF USES OF WELDABLE THERMOPLASTICS

2.1. Polyethylene

Polyethylene has a simple structure. It is made from a monomer called ethylene. Carbon and hydrogen are the two main constituents of the polyethylene material. Two main types Polyethylene are low-density polyethylene (LDPE) and high-density polyethylene (HDPE).

2.1.1. High density Polyethylene (HDPE)

High density Polyethylene was developed in the year 1950. It is a low cost material. It exhibits linear structure and it is a crystalline material. It has a high mechanical strength. Bilici M.K. et al. (2011) conducted welding of high-density polyethylene sheets.

2.1.2. Properties

Density 0.93 to 0.97 g/cm^3; high heat resistance; Bilici M.K et al. (2011) melting point of HDPE is 132^{0}C; very good resistance to alcohols; high strength; good insulating properties; not transparent and available at low cost.

2.1.3. Fields of use

Milk jugs, Furniture, Auto parts, several household products like garbage containers, toys, industrial and decorative fabrics, detergent containers

2.1.4. Low density Polyethylene (LDPE)

Low-density polyethylene was developed in the year 1930. LDPE exhibits branched structure and it is not a crystalline material. It has a lower mechanical strength as compared to HDPE but it is more flexible type of material. Bilici M. K et al. (2012) studied welding of polyethylene sheets.

2.1.5. Properties

Density 0.910-0.940 g/cm^3; melting point 105-115^{0}C; more flexible; it is transparent; exhibits good shock resistance even at low temperatures; melts at a lower temperature; low cost polymer with good process-ability; very low water absorption.

2.1.6. Fields of use

Bags, Flexible tubing, water pipes, hoses, Films, containers, Bottles, laminations.

2.2. Polypropylene (PP)

Polypropylene exhibits linear Structure. It is made from monomers called Propylene. PP is an intermediate material between HDPE and LDPE i.e., neither it is hard nor it is soft. Polypropylene has the ability to deform without fracture or breaking i.e., it is a tough and flexible material. PP is also available at a very low cost. Arici A et al. (2008) conducted welding of polypropylene.

2.2.1. Properties

Density 0.895-0.92g/cm^3; high melting point 160-166^{0}C; resistance to Chemicals such as acids, alkalies; good insulation properties; high tensile strength as compared to LDPE; high impact strength as compared to LDPE; transparent material; not affected by water.

2.2.2. Fields of use

Household products including translucent parts, ropes, syringes, Masks, automotive parts, consumer plastics, house wares, furniture, Appliances, Toys.

2.3. Polyamides (PA)

Polyamide is also called as Nylon. It is produced from monomers called carboxylic acid and amine Different polyamides are Nylon-6, Nylon-6, 6 which is most common polymer, Nylon-6, 10, Nylon-11 and Nylon-12. Polyamides are considered as high performance plastics. Imad et al. (2015) conducted friction stir welding of polyamide sheet and investigated mechanical properties of the joint.

2.3.1. Properties

Density 1.01-1.15 g/cm^3; melting point 190^0-325^{0}C; Flexible and rigid polymer; heat resistance; high tensile strength; resistance to chemicals; resistance to friction; high moisture absorption.

2.3.2. Fields of use

Used in Automobile, electronic, and packaging Industries. Also used to make toothbrush, comb, shoes soles, and pivots.

2.4. Polymethyl Methacrylate (PMMA)

PMMA is produced from monomer called methyl methacrylate. PMMA is an amorphous polymer and used mainly in automotive industry. It is a rigid material and transparent. Oliveria et al. (2010) studied welding of PMMA plastics.

2.4.1. Properties

Density 1.18 g/cm^3; melting point 190^{0}C; excellent transparency; high surface hardness; good insulating properties; poor impact resistance; resistance to chemicals; resistance to UV radiations.

2.4.2. Fields of use

PMMA materials are mainly used in automotive industry, hospitals and medicals. Also it is used in making Smart phones screens, Lenses, Solar panels and furniture's.

2.5. Polycarbonates (PC)

Polycarbonate is made from monomers bisphenol and diphenyl carbonate. It is an amorphous polymer. PC is tough and transparent thermoplastic. Panneerselvam et al. (2014) conducted welding of nylon 6 plates.

2.5.1. Properties

Density 1.2-1.22g/cm^3; melting point 155-235^{0}C; resistance to heat; high impact strength; high dimensional stability; durability; good insulation properties; resistant to UV radiation; chemical resistance.

2.5.2. Fields of use

Automotive-Used in car's interior and exterior body parts. Electrical, electronics, appliances and consumer products.

2.6. Acrylonitrile Butadiene Styrene (ABS)

ABS is an amorphous plastic. It is made of mainly three monomers i.e., Acrylonitrile, butadiene and Styrene. As ABS is amorphous, it is a high impact resistant plastic. ABS plastic is mainly used in automotive industry as it has excellent properties. Bagheri et al. (2013) Studied welding ABS sheets.

2.6.1. Properties

Density 1.07g/cm^3; melting point 230^{0}C; high impact resistance; Good insulating properties; Good weld-ability; good dimensional stability; Insoluble in water; High degree of surface quality; Exhibits good insulating properties; Very good resistance to chemicals.

2.6.2. Fields of use

Automotive parts, electrical and electronic parts and in making home appliances. Also used to make helmets, pipes, Telephone and water panels etc.

III. CONCLUSION

This paper presents the properties and the fields of use of the important thermoplastics, which are weld-able like (polyethylene, polypropylene, polyamide, poly methyl methacrylate, polycarbonates, Acrylonitrile Butadiene Styrene). Knowing the properties of materials makes it possible to easily join similar as well as dissimilar materials. As thermoplastics possesses excellent physical and mechanical properties, thermoplastic materials are used in many fields such as automotive, aerospace, electrical and electronic industry, sports equipment industry, toys, home appliance, packaging industry etc.

IV. REFERENCE

[1] Bilici M.K., Yukler A. I. (2012). Influence of tool geometry and process parameters on microstructure and static strength in friction stir spot welded polyethylene sheets, Materials and Design, 33, 145-152. DOI: 10.1016/j.matdes.2011.06.059

[2] Bilici M.K, Yukler A.I. (2011). The optimization of welding parameters for friction stir spot welding of high density polyethylene sheets. Materials and Design, 32, 4074-4079. DOI: 10.1016/j.matdes.2011.03.014

[3] Arici A, Mert S. Friction stir spot welding of polypropylene (2008). Journal of Reinforced plastics and composites,27, 2001-2004. DOI: 10.1177/0731684408089134

[4] Imad M. Husain, Raed K. Salim (2015). Mechanical properties of friction stir welded polyamide sheets. International journal of mechanical and Materials engineering 10:18 DOI: 10.1186/s40712-015-0047-6

[5] Oliveria P.H.F, Amancio-Filho S.T., dos Santos J.F., Hage E (2010).: Preliminary study on the feasibility of friction spot welding in PMMA. Materials Letters, 64, 2098-2101. DOI: 10.1016/j.matlet.2010.06.050

[6] Panneerselvam, K, & Lennin, K. (2014). Joining of nylon 6 plate by friction stir welding process using threaded pin profile. Material and Design, 53, 302-307.

[7] Bagheri, A, Azdast, T, & Doniavi, A. (2013). An experimental study on mechanical properties of friction stir welded ABS sheets. Material and Design, 43, 402-409.

[8] Arbon K, Wahit MUB, Bahraeian S (2011). A study on thermal and electrical properties of high-density polyethylene /high-density polyethylene grafted maleic anhydeide/montmorillonite/prlypyrrole blend. Int. J. Phys. Sci., 6(28): 5895-5902.

[9] Arici,A, & Sinmaz, T. (2005). Effect of double passes of the tool on friction stir welding of polyethylene. Journal of Material science, 40, 3313-3316.

[10] Aydin, M. (2014). Effect of welding parameters on fracture mode and weld strength friction stir spot welds of polypropylene sheets. Polymer-Plastics Technology and Engineering, 49, 595-601.

[11] Hoseinpour Dashatan, S, Azdast, T, Rash Ahmadi, S, & Bagheri, A. (2013). Friction stir spot welding of dissimilar polymethyl methacrylate and acrylonitrile butadiene styrene sheets. Material and Design, 45, 135-141.

[12] Shaikh, A, Bhatt, KD, & Chaudhary, AB. (2014). Effect of friction stir welding process parameters on polymer weld. International Journal for Technological Research in Engineering, 9, 741-743.

[13] Sorensen, CD, Nelson, TW, Strand, SR, Johns, C, & Christensen, J. (2001). Joining of thermoplastics with friction stir welding. ANTEC, 1, 1031-1035.

[14] Strand, SR, Carl, DS, & Tracy, WN. (2003). Effects of friction stir welding on polymer microstructure. ANTEC Conference Proceedings: Brigham Young University.