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Preparation of 3D Printing Filament from Face Mask Waste

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Abstract:- Recycling of plastics is one method for reducing environmental impact and resource depletion. The only way to decrease the environmental problems caused by polymeric waste accumulation produced from day-to-day applications of polymer materials such those used in packaging and construction is by recycling. It reduces the quantity of residues in landfills. This study has been investigated the recycling of face masks waste during manufacturing. Face masks waste is identified as polypropylene (PP) through FTIR and DSC tests. The recycled polypropylene from waste mask was collected and converted into pellets. The pellets have been converted into filament using a filament extruder. Agarose gel has been added for improving the adhesive nature of PP. Hardness tests were performed for the PP and agarose gel blended PP samples through Rockwell hardness machine. Micro structure of both the materials were analyzed through Optical Microscope.

Keywords:- *Face mask material, Polypropylene, Waste management, Recycle.*

I. INTRODUCTION

Plastic pollution is one of the biggest problems to the environmental protection. The emergence of COVID-19 pandemic further intensified the situation since 2019. Residents were scrambled to protect themselves from the COVID-19, leading to a soaring consumption the personal protective equipment (PPE), such as masks, hand sanitizer and gloves. It seems that single-use plastics are imperative, but the current situation of the disposal of PPE became a problem.

However, the situation of COVID-19 is much more serious than the SARS, accordingly, the demand for face mask far exceeds the estimated quantity in the past. It is conceivable that a gigantic amount of plastic waste would be produced owing to this pandemic. In this research paper, commercially available disposable face masks waste and rejected material were collected from the mask manufacturing vendors. Here, materials are fed into plastic granules making machine and the materials get heated at some particular temperature. So, that it gets melted and extracted into wire with the help of extruder. After this process that wire get chopped into small granules. With this granule it is easy recycle into any other product and also easy to test the material. In these masks, filtering is accomplished by combining an electrostatic charge and a web of polypropylene microfibers. Polypropylene sheets produced using spun-bond or melt-blown technique are the primary textile used to mass-produce face masks. Even though there are many different kinds of biopolymers on the market. So, some chemical, thermal and mechanical characteristics test is done to find the polymer. [1-3].

II. RAW MATERIAL

The main motto of this project is Waste Management system and also environmentally friendly. Here waste material of surgical mask during production are converted into pellets and test its property for further uses. So, the waste mask material was collected from the mask manufacturing company. While this production of mask some of the materials are get rejected and also some of the side are get trimmed like in fig.1. So, this material is taken as a raw material for this research. Because this is same mask material but it is not used so that it will not affect anybody. [4-6]

Fig. 1: Waste Mask Waste

III. PROCESS METHODOLOGY

Plastics are one of the most commonly used materials in the world today. The huge quantities of plastic products currently being marketed will ultimately find their way to the waste dump sites. This is creating a very serious problem at dump sites for a number of reasons. The inert nature of plastic materials renders them resistant to bio-degradation which leads to an increase in the number of plastic wastes in dump sites. Moreover, the presence of plastic wastes in the environment is considered to be a hazardous affair for they are liable to catch fire easily, burn for long periods of time and thus pollute the atmosphere. They also abuse arable soil for farm work. Consequently, action should be taken to promote recycling of plastic materials. Plastic recycling is bound to realize a lot of saving in production costs, conserve limited resources, and alleviate environmental pollution. Here this plastic granule making machine plays a major role. Machine convert waste material into granules as shown in fig.2.

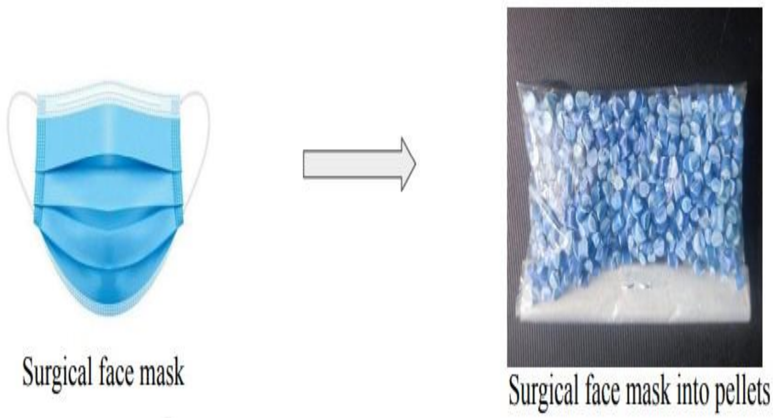

Fig. 2: Convert Mask Waste To Pellets

IV. AGAROSE PREPARATION

Agarose is available as a white powder which dissolves in near-boiling water, and forms a gel when it cools. Agarose gels are usually prepared using a weight/volume solution in the 0.5-3% range. So, 3% agarose gel, add 1.5 grams agarose to 50ml water. Allow the agarose to sit in solution for a few minutes before swirling the beaker and suspending it in the solution. Cover the mouth of the beaker with plastic wrap and make a small hole in the top to allow the solution to vent. Heat the beaker at above 100°C for 30 minutes with the help of Autoclave. Then kept cool at room temperature for 15 minutes after that agarose gel is formed.

V. FOURIER TRANSFORM INFRARED SPECTRA (FTIR) RESULT

Face masks are made with a variety of polymers and inorganic materials, although there is typically no precise information about their make-up. This makes it essential to utilize FTIR to classify the different sorts of materials being used. The final FTIR spectra of the face mask components are displayed in Fig 3.

Samples revealed similar bands in the two large regions between 2835 and 2952 cm^{-1} and also between 1211 and 1552 cm^{-1}., which describes the polypropylene FTIR spectrum (PP). Four large bands were visible in the FTIR spectrum, with wavenumbers ranging from 3000 to 2800 cm^{-1}. Bands at 2950 and 2865 cm^{-1} were attributed to CH_3 asymmetric and symmetric stretching vibrations, respectively, while bands at 2915 and 2865 cm^{-1} were caused by CH_2 asymmetric and symmetric stretching vibrations. Additionally, two strong bands at 1452 and 1375 cm^{-1} were visible in the FTIR spectrum and were attributed to the CH_3's asymmetric and symmetric deformation vibrations, respectively. C-C asymmetric stretching, CH_3 asymmetric rocking, and C-H wagging vibrations may be responsible for the band at 1165 cm^{-1}. IR analysis results show that sheets of polypropylene were used to make the masks.

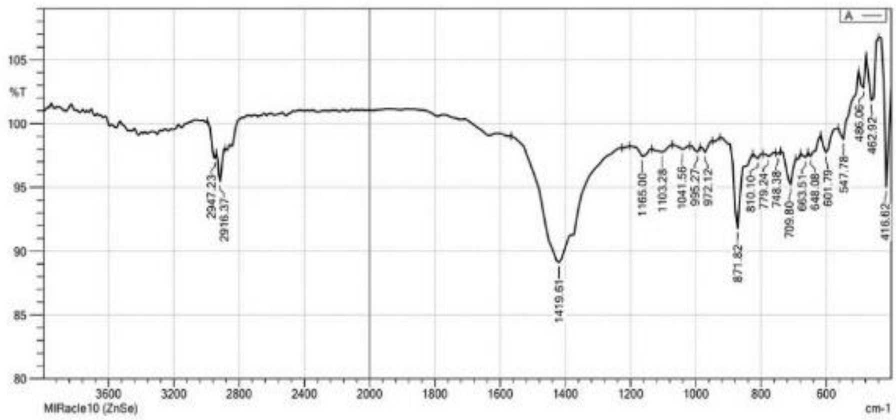

Fig. 3: FTIR Graph Result.

VI. DIFFERENTIAL SCANNING CALORIMETRY (DSC) RESULT

To confirm the blend's composition and thermal characteristics, a DSC thermal study was performed. The results obtained in thermal analysis in terms of enthalpy and peak temperature respectively at the second heating step, in Fig.4. the thermograms curves are shown the melting points observed at the thermograms here the melting point as shown from the graph is 163.89 °C (Tm). So, the result is related to the melting point of Polypropylene.

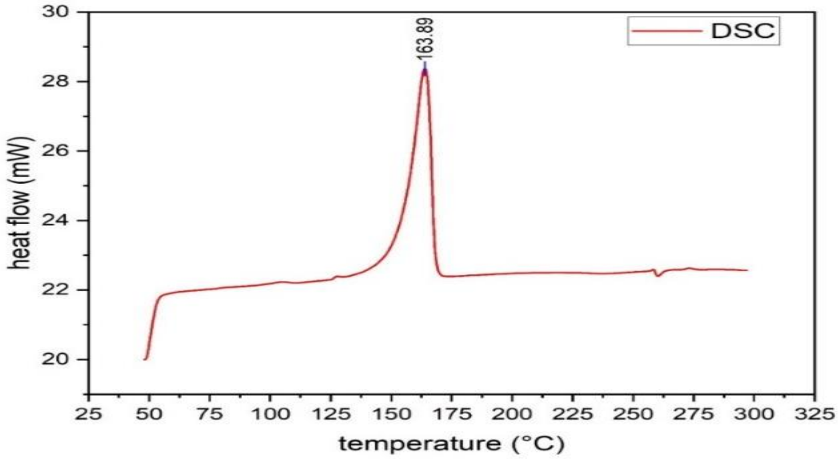

Fig. 4: DSC GRAPH RESULT

VII. FILAMENT EXTRUSION MACHINE

Friend Machinery's high-precision 1.75 mm lab 3D printer filament extruding machine is used to extrude the filament. Polypropylene material without any additives is fed to the hopper. Filament extrusion was done properly, as shown in fig.5, but the material is very brittle because the recycled material lost its own properties. Inside the hopper, polypropylene material with agarose gel was dropped. Because the filament was not extruded properly, more porosity formed due to the moisture content present inside the material, as shown in fig.6.

Fig. 5: PP FILAMENT

Fig. 6: PP+ AGAROSE FILAMENT

VIII. ROCKWELL HARDNESS TEST

Hardness is a mechanical property that indicates a material's resistance to localized plastic deformation caused by a mechanical indentation. In engineering, hardness is mainly used for the determination of material properties of various materials. the Rockwell hardness number is always followed by the symbol HR and scale designation symbol. Scale L is set for plastic material, and a 60 Kgf load was applied. The 1/16" ball indentor was selected and tested. Hardness tests were performed for the PP and agarose gel blended PP samples through Rockwell hardness machine. Hardness was increased according to the result shown in Table.1.

Table 1: Rockwell Hardness Test Result

MATERIAL	SAMPLE 1	SAMPLE 1	SAMPLE 1	AVERAGE
Polypropylene	103 HRL	109 HRL	105 HRL	105.67 HRL
Polypropylene + Agarose	146.3 HRL	150.2 HRL	152.5 HRL	149.65 HRL

IX. MICROSCOPE RESULT

Microscope images of the polypropylene and polypropylene with agarose are shown in Figs. 7. Polypropylene with an agarose image Fig.7 shows the clear-cut view of polypropylene, agarose, and porosity, which formed due to the moisture content present inside it. And Fig. 7 shows that the polypropylene without additives has no porosity in the filament. Metscope I microscope was used to analyse the images of the samples.

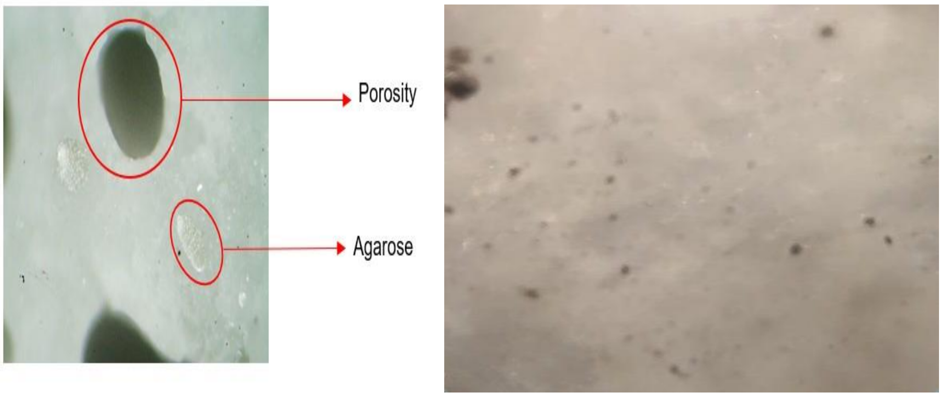

Fig.7: Microscopic View of PP with Agarose Filament and Microscopic View of PP Filament

X. CONCLUSION

This study demonstrated the possibilities of recycling the face mask waste by slicing it into pellets. and converted into filament using a filament extruder. Initially the band distribution on the FTIR spectrum of the Mask waste samples shows that the identical bands in the two broad ranges from 2835 to 2952 cm−1 and from 1211 to 1552 cm−1 which represent the FTIR spectrum characteristic of polypropylene (PP). This test result has been concluded that the prepared sample using waste mask is made up of Polypropylene. And the thermal analysis by DSC was carried out to verify the material; The results showed that the melting point is 163.89 °C (Tm) So both results conforms that the waste material from the mask is polypropylene. During extrusion, Polypropylene extruded properly, but the extruded material was brittle because, during recycling, it may lose its own properties. Agarose gel is added for improving the adhesive nature of PP. Hardness tests were performed for the samples of PP and PP with agarose gel. Hardness results show that the brittleness of the polypropylene filament. The microstructure of both materials was analyzed through Optical Microscope. [7-8]

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