Prototypic Volumetric Gradient Sensor for Optimizing Polyethylene Terephthalate Recycling by Pultrusion

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Single-use PET bottles, while providing numerous applications worldwide, are a major source of micro-plastic contamination. PET filament pultrusion is one technique for recycling PET bottles where the bottles are converted into linear strips to produce 3D printing filament. However, certain limitations such as degradation (and/or fragmentation) exhibited by the bottles, due to environmental stressors, plague the system's productivity as the volumetric inconsistencies of the strips are also reflected in the quality of the filament produced using them. Hence, we have designed a "gradient" sensor to actively detect these inconsistencies and rectify them by altering the speed of the putrusion process, to maintain the filament's uniformity. Our sensor houses a set of levers that amplify the movement of a magnet, produced by the surface profile of the strips, which can then be detected by a hall effect sensor and conveyed to a microcontroller. After experimentation with various parameters such as the operating frequency of the Hall effect sensor, the temperature of the nozzle, and nominal pull rate in order to maximize effectiveness, the best results were obtained with the following configuration: Frequency of 200 Hz, nozzle temperature 235 °C with a pull rate of 0.38 cm/s. Upon inspection of the filament produced, it was observed that its mean diameter was 2 mm with a maximum deviation of 0.05 mm. If contrasted with the maximum deviation in the strips (pre-processing) of 0.36 mm, there was a reduction in the max deviation by approximately 86.11 %.

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