3D printed gyroid lattice structures from recycled PET (rPET) for electric vehicle battery crash protection

K. W. S. N. Wijesundara, C. D. S. Kelum, E. M. J. C. Ranasinghe, K. D. R. N. Kalubowila, K. M. G. S. U. Kariyawasam

Department of Instrumentation and Automation Technology, Faculty of Technology, University of Colombo, Sri Lanka

The rapid growth of electric vehicles into urban and commercial transportation has driven the need for a lightweight but strong battery enclosure capable of withstanding impacts and vibrations during a vehicle crash. Since most rechargeable batteries are prone to mechanical failure and fires upon collision or impact, advanced crash-resistant structural solutions need to be deployed to ensure the safety of the driver and system functionality. Simultaneously, sustainable engineering practice is a prime necessity as reflected in the rising plastic pollution due to the accumulation of non-biodegradable waste in the environment. Recycling and reusing industrial and post-consumer plastics are necessary to reduce damage to the environment and promote circular production. To overcome the issues of sustainability and safety, this study proposes the optimum gyroid lattice structures fabricated by fused deposition modeling (FDM) 3D printing with recycled plastic for crash protection applications. In the current research, recycled polyethylene terephthalate (rPET) was used from industrial broom wastes derived from post-consumer plastic bottles as a viable and sustainable material option. Due to the diameter difference, the industrial broom waste rPET filament was extruded using a redesigned filament extruder integrated into the FDM 3D printer. This allowed continuous material feeding during the printing process. Quasi-static compression was employed to test gyroid geometries that were printed. The best strength-to-weight ratio was observed in the 12 mm cell size 25% relative density configuration, indicating excellent crashworthiness that is favorable for safety parts in electric vehicles. The gyroid lattice structures offer an environmentally friendly, lightweight, and extremely low- cost battery protection solution by substituting the conventional solid or foam-filled crash protection components with optimized gyroid lattice structures made of industrial rPET waste. This material innovation combines mechanical and other functionalities, offering a scalable solution to advance concepts of circular economy in future-proof electric mobility solutions.

Keywords: *Recycled polyethylene terephthalate (rPET), Gyroid lattice, Fused deposition modeling (FDM), Quasi-static compression, Strength-to-weight ratio*