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Experimental Study of Virgin ABS, Recycled ABS and Basal Fibre-Recycled ABS Composites by Hot Press

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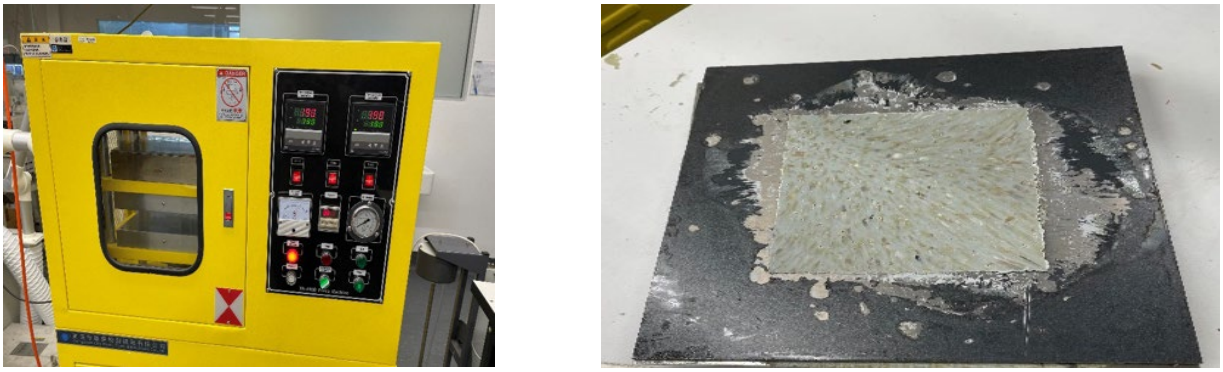
Extended Abstract:

The ongoing massive depletion of renewable and non-resources around the globe has presented the grave concern for human society. One material that requires sustainable practices is plastics, consumed widely in the world. According to a discussion paper by Anderson and Gbor (2024), till 2020-2021, annually Australia generates around 3.8 million tons of plastics out of which around only 0.4 million tonnes are recovered, and rest are being disposed to land and water. Out of varieties of polymers, ABS and PLA are some of the most popular for the manufacturing processes in the 3D printing industries. ABS plastics are also found in household items. Source of waste in the 3D printing industries are failed prints, support materials and unneeded or obsolete 3D printed models. This study aims to examine the mechanical properties of composite materials of basalt fibre and recycled ABS, including tensile, flexural and impact properties. In this study, pellets of virgin ABS are used as a baseline for understanding the degradation in recycled plastics.



(a) Hot press machine XH-406B *(b) Heat moulded polymer composites*

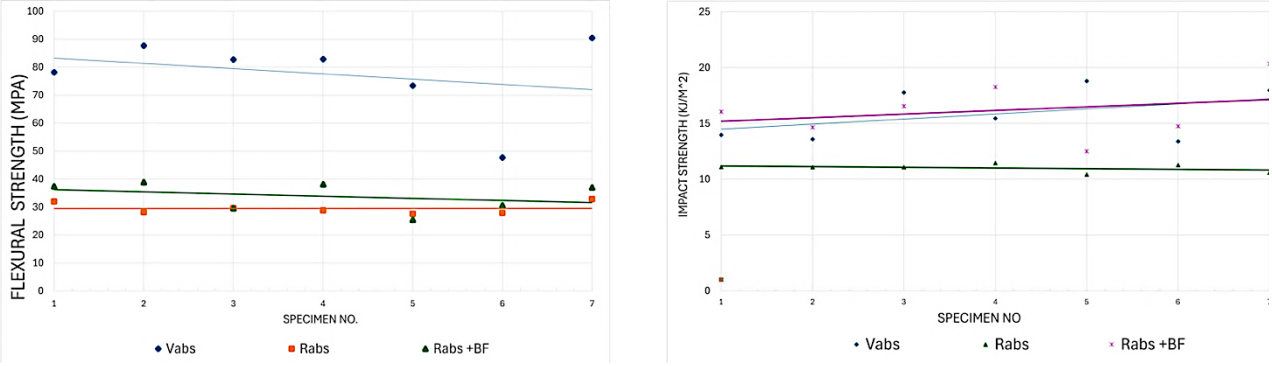
Fig. 1 Hot pressing of basalt *fibre - recycle plastic composites*

The material fabrication method used for sample preparation are similar to those described in literature (Lee & Kim, 2012; Peng & Zhang, 2018). This method is also referred to as compression moulding (Kandar & Akil, 2016; Kamran, et al., 2021). The recycles materials received from a local recycle company were shredded to 3-mm granules using a GP20 shredder/granulator. The shredded plastic samples were then compression moulded using a digital hot press, XH- 406B, shown in Fig. 1a, at 3 different temperatures close to the glass transition temperatures of ABS to fabricate composite sheets. As for the mould set, 3 stainless steel plates of 3 mm thickness were used as mould for the recycle plastic sheet. The middle sheet has a cut out cut out of 165 mm × 165 mm for the placement of shredded recycle plastic. Figure 1b, shows heat moulded plastic sheet in the middle plate. The

average weight of ABS and PLA shredded plastics is about 150 g to fit into the cut-out mould. Shredded granules were spread evenly in the cut out stainless sheet for the preparation of flat sheet using the XH406B hot press. Mould release wax was applied on the on the top and lower metal plates and the edge of the central stainless plate. ABS plastic sheets were formed at different temperatures of 190, 200, 210, 220°C. The hot press holding times were varied to determine the optimum time for hot press. The optimum temperature of 210°Cwas now used for 5% basalt fibre composites with recycle plastic. The percentage composition of fibres was also varied to determine the investigate the effect of fibre on the composite strength.

The hot-pressed sheets were then cut into dogbone shapes using water jet cutter. The sizes of the dogbone specimen were designed according to ASTM D638 Type 1 for tensile test, ASTM D790 for the flexural test and a standard Charpy impact test specimen according to ASTM D6110, respectively. The tensile and flexural tests were carried out on Instron Universal Testing Machine and the impact test used Instron Charpy Impact Testing Machine. All test samples were conditioned at room temperature. Each mechanical test was performed under similar temperature ASTM standards. Five test specimen samples are required by all 3 mentioned standards. However, seven test specimens were fabricated and tested for receptivity. vABS is the virgin plastic, rABS is the recycle plastic and rABS+BF is the reinforced recycle plastic composites with basalt fibre.

Figure 2a shows the flexural strength of recycle plastic is lower than the virgin. Adding basalt fibre as a composite increased the flexural property by about 11% but not back to the level of virgin plastic. Figure 2b shows the impact strength results of the seven specimens. The impact property of rABS is low in comparison virgin. Reinforcing the plastic using the basalt fibre seems to improve the impact property. This shows that natural fibre like basalt fibre can play the key role on the sustainable practices of the industry by increasing the durability of the plastics.



(a) Flexural strength *(b) Impact strength*

Fig. 2 Material Properties of recycled ABS (rABS), virgin ABS (vABS) and basalt fibre-ABS composites

Experimental data shows the mechanical properties of the recycled ABS and basalt fibre-ABS composites are quite different from virgin materials. Some mechanical properties can be improved by adding natural fibres. Basalt fibre is one of the candidates for this. There is a need to do more research to understand the reasons for changes in mechanical properties. Further material characterisation of recycle plastic like Thermogravimetric analysis (TGA), Differential scanning calorimetry (DSC) to understand the changes in recycle polymers.

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