Application of Magnetic Field to Flow Properties of Molten Thermoplastics in Polymer Processing Techniques

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Abstract: Magnetic field was applied to molten thermoplastics during the flow in two different processing techniques; one in extrusion process and the other in thermal spray coating technique. In extrusion process, the effects of the magnetic flux direction and density, die temperature and wall shear rate on the extrudate swell and flow properties of various thermoplastic melts were investigated. The results suggested that an increasing wall shear rate increased the swelling ratio for the PS, LLDPE and PVC melts, but the opposite effect was observed for the ABS and PC melts. The extrudate swell ratio for the PS, ABS, PC, and LLDPE melts decreased with increasing die temperature, the effect being reversed for the PVC melt. Thermoplastic melts having high benzene content in the side-chain and exhibiting anisotropic character were apparently affected by the magnetic field, the extrudate swell ratio increasing with magnetic flux density. The effect of the magnetic field on the extrudate swell ratio decreased in the order of PS $\longrightarrow$ ABS $\longrightarrow$ PC. For radial extrudate swell, the radial swell ratio for a given shear rate decreased with increasing r/R position. There were two regions where the changes in the extrudate swell ratio across the die diameter were obvious, one around the duct centre and the other around r/R of 0.65-0.85. The changes in the extrudate swell profiles across the die diameter were associated with, and can be explained using, the melt velocity profiles generated during the flow. The changes in the overall extrudate swell ratio of PS melt in a capillary die were influenced more by the swelling of the melt around the centre of the die. In thermal spray coating technique, a magnetic field has been applied for the first time to Fe-substrate which was thermally-spray-coated by poly[ether-ether-ketone] (PEEK). The effect of magnetic intensity on adhesion index and hardness of the PEEK coatings was investigated. The experimental results suggested that the adhesion between the PEEK coating and the substrate, and the hardness of the coatings increased due to the change in degree of crystallinity of the PEEK as a result of the magnetic field application.

Key words: Thermoplastics, Melt extrusion, Thermal spray coating, Magnetic field, Elastic effect

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