The effect of material defects on the fatigue behaviour and the fracture strain of ABS

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Abstract

The structural integrity and durability of a construction are highly dependent on the material quality. Poly(Acrylonitrile-Butadiene-Styrene) Copolymer (ABS) is a material which is preferably chosen for high performance products, because of its superior toughness. The toughness of ABS is revealed by its high fracture strain in a tensile test, and high notched
Izod impact fracture energy. However, the fatigue resistance of ABS is less favourable. This investigation is mainly devoted to the fatigue behaviour of ABS and to the fracture strain and the notched Izod fracture energy. Various mechanical tests, performed in conjunction with scanning electron microscope investigations of the fracture surfaces, demonstrate that
fracture initiates from small defects which are abundantly present in the material. Especially the fatigue fracture surfaces show numerous cracks which had initiated from the defects.
The fracture strain in tensile tests is high, but shows a large scatter. It is demonstrated that the fracture strain is also related to the presence of defects. A pre-fatigue load up to 40% of the anticipated fatigue life, followed by a tension test shows a significant reduction of the fracture strain as compared with a tension test on non damaged as-moulded
material. Microscopic investigations show that this fracture strain reduction is caused by the presence of small cracks which initiated from the defects, during the preceding fatigue load. A similar but much smaller effect of pre-fatigue was observed for notched Izod tests.
Finally it is concluded that the fatigue behaviour of ABS is dominated by the growth live of microscopic small cracks from material defects.