Experiment title:

A preliminary study on the deformation mechanisms in rubber toughened amorphous polymers

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SC-208

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Report:

Recently, a new route has been developed within our laboratory to prepare rubber toughened poly(methyl methacrylate) (PMMA)[1]. Earlier research has shown that brittle amorphous polymers (e.g. polystyrene (PS) and PMMA) can be toughened via the introduction of an extremely fine rubber morphology. Once the interparticle distance between rubber particles becomes smaller than a critical value, a toughened blend is obtained. This is explained as a transition in microscopic deformation mechanism. The reported results are a first attempt to study the relation between the morphology, both type and size, and the mode of deformation on microscopic level. ultimate objective is to determine the importance and contribution of the different microscopic deformation mechanisms such as crazing, shear yielding and (rubber) cavitation on the macroscopic degree of toughness.

The scattering patterns of four different PMMA /rubber composition (90/10, 80/20, 70/30 and 50/50) are studied during deformation in a tensile test Rheometrix Mini-Mat, miniature tensile machine, strain rate 0.05 mm/min ($1\cdot10^{-3}\,s^{-1}$)). Tests performed in our laboratory showed that the deformation behavior of the blends changes depending upon the rubber concentration. In a tensile test the blend modified with only 10 **wt%** rubber behaves brittle, like neat PMMA. The small angle X-ray scattering patterns as function of time during the test are presented in the figure below. Since no scattering pattern is present as a result of the rubber morphology, all observed changes are attributed to the deformation on microscopic level. After a certain degree of deformation, sharp streaks in the tensile direction become visible (7-1 O). Upon further deformation a star shaped pattern develops which increases in size (11-16). These kind of patterns have been reported before and are ascribed to the development of the crazes, i.e. small micro-cracks bridged by thin fibrils (5-30 nm thick)[3]. This is confirmed by *in-situ* SAXS-tensile test performed by us and *in-situ* SAXS-impact tests reported in literature on high-impact-polystyrene (HIPS) from which it is well known that it deforms via multiple-crazing[4].

If more rubber is added, the PMMA/rubber blends behave ductile during tensile testing. ***In-situ*** SAXS-tensile tests show for the 80/20 blend completely different deformation patterns as shown below for the 90/1 O blend which are most likely the result of rubber cavitation. Moreover, for the 70/30 and 50/50 blends again clearly different patterns are observed which have not been reported before and are not yet explained. *Experimental observations shown here are preliminary, further detailed studies in a range of blends are desired.*

The reported results will be published and a proper acknowledgment to the co-workers of the ESRF will be made.

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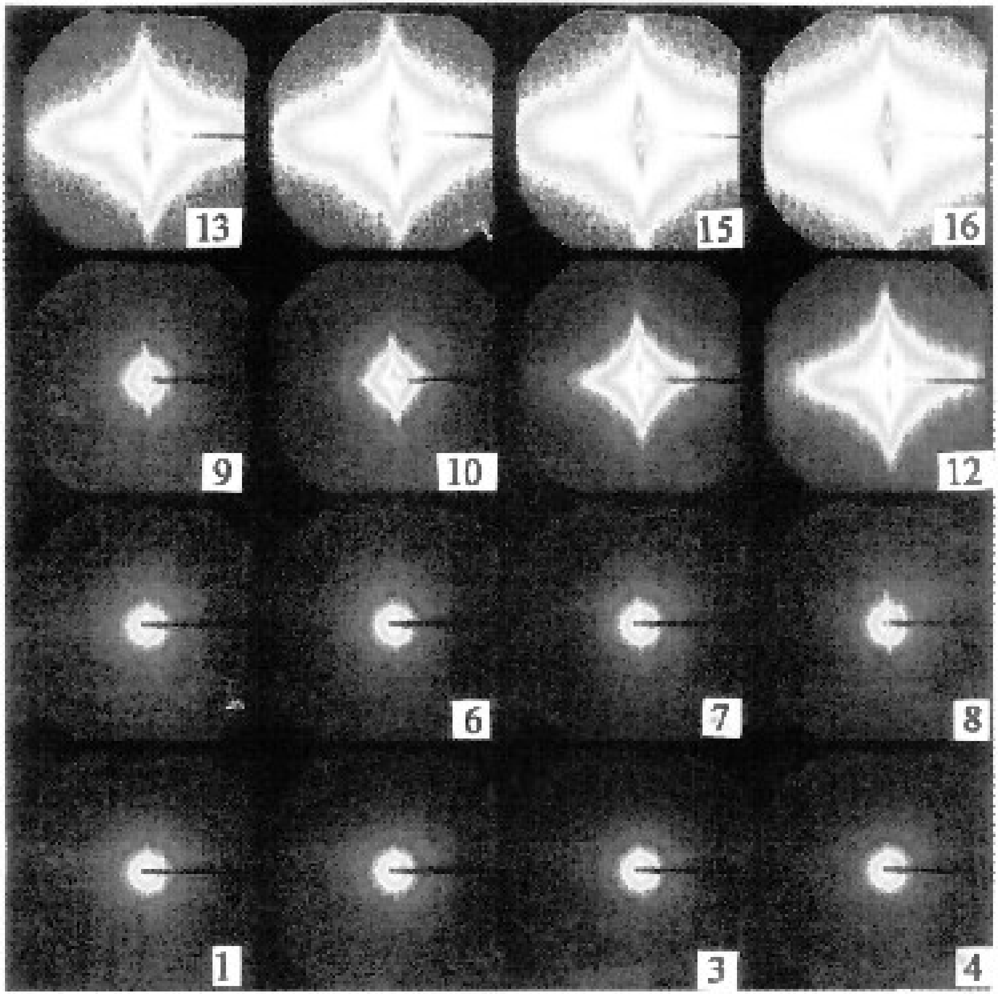
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