Int. J. Solids Structures, 1968, Vol. 4, p. 1243. Pergamon Press. Printed in Great Britain

ONE OF THE FEATURES OF THE STRUCTURE OF THE ZONE NEAR THE TIP OF A CRACK

N. P. NOVIKOV

Institute of Mechanics, Academy of Sciences USSR

IN STUDYING the propagation of cracks in solid bodies the greatest interest centers around the tip zone. There exist different points of view concerning the shape of this tip region and the magnitudes of stresses there. All investigators, however, are unanimous in the assertion that near the origin of the crack, a certain ultimate stress must be reached which determines the development of the crack. It is quite obvious that these ultimate stresses may lead not only to the development of the crack (surmounting the cohesive forces) but may also lead to changes in the material itself.

It is known that in polymers (such as nylon, polyethylene, polypropylene, etc.), as the uniaxial loading reaches a definite value, orientation occurs and the strength of an oriented polymer is much higher. It may be assumed that in such materials, as the crack moves along as a result of large stresses, orientation of the polymer occurs in the vicinity of the tip zone. Therefore, the development of a crack in these polymers will be strongly connected with fracture of an oriented polymer as it exists near the tip of the crack.

With the example of development of incisions (seed cracks) in films of polyethylene and polypropylene, it was established that the assertion stated above indeed is valid. In the experiment, films of thickness of 30 to 50 μ were used with different supermolecular structure. The extension was observed with a microscope in polarized light which permitted to detect changes in the supermolecular structure.

As seen, Fig. 1, the development of the crack is connected with the formation, at its tip, of oriented polymer. As the crack moves along, fracture of this oriented polymer occurs. This feature in the structure of the zone near the crack tip was observed both in polyethylene and polypropylene and did not depend on supermolecular structure.

Theoretically, the described structure of the tip zone was predicted in [1], where the kinetics of crack development was studied. In [2], Frank also detected that oriented polymer is formed near the tip of the crack even though this does not determine the specifics of the structure of the end zone. Thus, on the basis of the experimental results described here and those of [1] and [2], it may be asserted that this development of cracks in polymers is strongly connected with the formation of oriented material in the tip zone, followed by its fracture.

REFERENCES

[1] G. I. BARENBLATT, V. M. ENTOV and R. L. SALGANIK, *Mekhanika tverdogo tela* (Mechanics of Solid Bodies) **5**, 82 (1966).

[2] F. C. FRANK, *Proc. R. Soc.* **A282**, 1388 (1964).

(*Received* 26 *December* 1967)

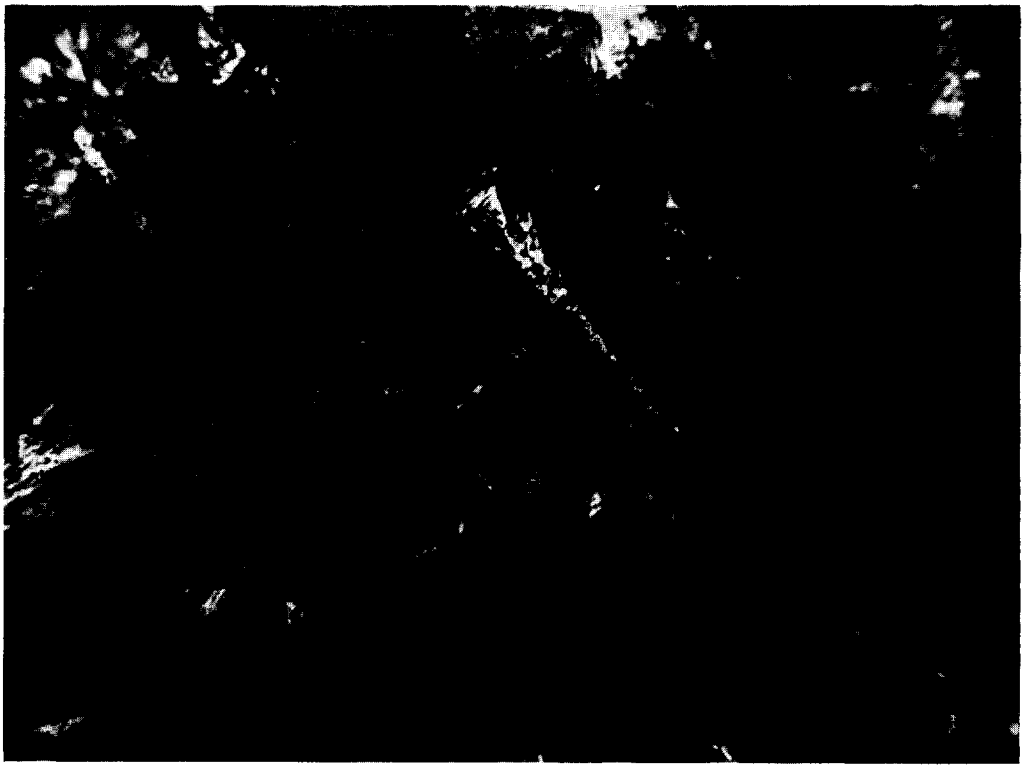

FIG. 1

facing p. 1244