

## Flow Properties of Polymer Melts

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George Godwin Ltd,  
Publishers, £22

The stated aim of this book is to provide an introduction to the flow properties of polymer melts and to relate these properties to industrial processing techniques, without invoking advanced mathematics. This is a somewhat daunting task in view of the highly mathematical nature of most of the theoretical developments of polymer rheology in recent years. However, with the possible exception of the final chapter, which endeavours to initiate the reader into the complexities of the tensor approach to continuum mechanics, it has been successfully accomplished. This is achieved by the use of relatively simple flow relations wherever possible, coupled with a descriptive or semi-quantitative interpretation of the underlying molecular mechanisms. To avoid undue interruption of the presentation of the general principles involved, the more important mathematical proofs are relegated to a series of appendices.

The general layout follows that of the first edition (1970), with significant additions to particular sections to include new developments. The more extensive of these additions are concerned with slip at the wall and end effects in flow through tubes, elongational flow, and the relationship between rheological properties and polymer structure.

The opening chapters set out the principles of classical rheology and define the main types of flow behaviour. In this, nomenclature is a problem, and the author is unduly restrictive in identifying the ideal elastic solid with the Hookean solid. Large (ideal) elastic deformations are essentially non-Hookean (except liquids (normal stress effects, elastic recoil, etc.) are directly associated with the highly-elastic (rubberlike) component of the deformation. Also it is regrettable that  $\Delta L$  is used for the shear displacement in a plane perpendicular to the  $L$ -dimension of the specimen. The terms 'apparent shear rate' and 'apparent viscosity' (p. 9) could be troublesome, particularly when we are later confronted with 'true apparent viscosity' and 'false apparent viscosity' (p. 25).

Succeeding chapters are concerned more specifically with methods of studying the properties of polymer melts in (viscous) shear flow and the dependence of these properties on the structure of the polymer and on such variables as temperature and pressure. This is the basic information needed for the understanding of industrially important processes.

The more complex elastic effects in flow are introduced by the consideration of the phenomenon of 'die swell' (i.e. radial expansion of the extruded jet) and of various forms of irregularity in extrusion. Following this is a chapter on elongational flow. This subject, though by no means new, has attracted increasing attention in recent years on account of its relevance to industrial processes such as melt spinning, sheet extrusion, blow moulding, etc. The experimental difficulties in this field are considerable, due to the fact that by the accepted definition of rate of elongational flow, the specimen length for constant flow rate increases exponentially with time. As a result,

steady-state conditions are rarely attained.

In most industrial processes the state of flow is neither simple shear nor simple elongation but more complex. This may be illustrated by the extrusion moulding process, for which it is necessary to know not only the flow pattern in the mould cavity but also that in the extruder barrel. Moreover, in the mould cavity the temperature is continuously changing until ultimate solidification occurs. Data which would enable a quantitative treatment of such a problem do not exist, and very drastic simplifications must be introduced in order to obtain some sort of result. Considerable space is devoted to this problem, and it is shown that, despite these restrictions, results of some practical significance may be deduced.

Taken as a whole, the book gives a well-balanced survey of the present state of development of both the theoretical and experimental aspects of polymer rheology. It can be strongly recommended to all who are in any way concerned with the subject.

L. R. G. Treloar

## An Atlas of Polymer Damage

L. Engel, H. Klingele, G. W.

Ehrenstein and H. Shaper

Prentice-Hall, Inc., Englewood

Cliffs, 1981, 256 pages,

\$78.00

The Atlas is the translation of German edition, entitled: RASTERELEKTRON-MIKROSKOPISCHE UNTERSUCHUNGEN VON KUNSTOFFSHADEN. It shows the different kinds of damage shown by high polymers, as seen under the scanning electron microscope. It contains three parts entitled:

- Structure, properties and processing of polymeric materials (49 pages)
- Surface damage (86 pages)
- Fractures (107 pages).

In the first part the authors discuss the structure of polymers, homogeneous and heterogeneous polymeric materials, the behaviour and deformation, the processing technologies, orientation and internal stresses, surface texture due to the manufacturing process, faults in the material. Here there are presented and explained, 60 images.

The second part deals with mechanical surface damage and physico-chemical surface damage and contains 165 electron microscope images, these are related to wear due to friction, uniform frictional wear of flat surfaces, local frictional wear, pitting, wear due to roller, wear due to bombardment with solid particles, impingement of droplets, erosion, cavitation, surface damage caused by chemicals, u.v. irradiation, weathering, effect of high temperature, biological effects.

More than 200 images are presented in the third part, reflecting load fractures, crazes, ductile fractures, brittle fractures, dynamic fatigue fractures, vibration-induced creep fractures, true vibration fractures, environmental stress cracking, permanent embrittlement after exposure to chemicals, increased ductility caused by chemical attack, partial solution of crack tip by chemicals.

The atlas has also four very useful appendices and an index. Production engineers, chemists, physicists and all others responsible for controlling polymer quality

and identifying the cause of any damage will appreciate the practical guidance, information and source of reference provided by this very interesting atlas.

D. Feldman

## ADVANCES IN POLYMER SCIENCE Vol. 34/35 1980

### Cationic Polymerisation – Initiation Processes with Alkenyl Monomers

A. Gandini and H. Cheradame

Springer Verlag US\$80.30

A review in 'Advances' is expected to have several important features, and the present work has them all, in generous measure.

*Comprehensiveness of subject:* The reviewer could think of no part of this wide field that has been neglected, though inevitably not all have been treated in the same degree of detail.

*Comprehensiveness of sources:* It would be a major achievement to find an important paper directly related to the subject which is not mentioned in the almost 1000 references. The main text was concluded in 1979, but the 'Notes added in Proof' with ca. 60 references bring the book up to mid-1980; many of these recent references are to work in manuscript, to Theses, or to Conference Proceedings.

*Breadth of view:* A very pleasing feature is the way many areas of physical organic chemistry (carbenium ions), inorganic chemistry (metal halides, acids) and organic reaction mechanisms are brought to bear in the arguments. The authors show themselves to be widely informed and interested: they are not this-chemists or that-chemists or polymer-chemists, but CHEMISTS I know of no greater distinction.

*Critical appraisal:* A necessary achievement of a good review is comprehensiveness but it is not sufficient. The difference between, say, a Royal Society of Chemistry Specialist Report and an original work like the present one is the critical element which impresses the writer's personality upon his material. One of the outstanding features of the present work is the way in which the authors have scanned with a penetrating beam of critical appraisal almost everyone of their topics. This criticism springs from a wide personal experience and an agile, extremely well informed imagination. Had they used this only in dissecting what has been done and in distinguishing the spurious from that which is well established and trustworthy, they would have deserved well enough of their readers; but they are amongst the very few who have had the insight, and the interest, to write what needs to be done, what needs to be tested again, and to point out which systems seem worthy of further exploration. Their advice should be heeded. Another rare achievement is that where they disagree with the interpretation of some observations they do not hesitate to offer their own alternative.

*Authority:* This is not the work of armchair chemists. It sparkles with the wide practical experience of these ingenious and resourceful experimenters, and this background imparts both to their criticisms and their suggestions the stamp of authority.

In short—a very enjoyable, useful, and thought-provoking book, well worth the money. It will be a good companion for many years to come.

P. H. Plesch