is of value as a source of Russian references on the subject, of which 247 are quoted; it is of interest that only about seventy of these are mentioned in Molchanov's publication. The inclusion of only eighteen American references (including texts) in the eighty-seven references quoted in other languages would suggest, in view of the considerable American contribution to this problem, not a little selection.

The translation on the whole appears to have been reasonably well done. There are some technical mistranslations and ambiguities, also certain errors in transliteration (for example, Kovita for Coweeta), but generally these are too few to cause any serious concern. Reproductions of graphs and line drawings are clear, but those of most of the photographs are so poor as to be virtually unrecognizable.

L. LEYTON

[1] Molchanov, A. A., *The Hydrological Role of Forests* (Moscow, 1960). Translated by Gourevitch, A., Israel Program for Scientific Translations, Jerusalem, 1963. (Oldbourne Press, London.)

# MOLECULES JOIN TOGETHER

## Polymerization by Organometallic Compounds

By Leo Reich and A. Schindler. Pp. x+740. (New York and London: Interscience Publishers, a Division of John Wiley and Sons, 1966.) 200*s*.

THE pioneering discovery of the zinc alkyls by Frankland was followed after a considerable interval of years by the more convenient method of Grignard, using organomagnesium derivatives. This led to rapid acceleration of the synthetical applications and also to a search for similar and possibly more selective methods. Of these, one of the more significant was the use of lithium alkyls. K. Ziegler was early engaged in this development and it led him, twenty years later, by way of an interest in lithium aluminium hydride, to the discovery of moderate polymerization of ethylene by trialkyl aluminium. A chance observation of the effect of nickel in promoting the decomposition of aluminium alkyls resulted in the further discovery of the high polymerization of ethylene by an organo–titanium–aluminium complex. This proved to be of immense theoretical and industrial importance, so that the relation of Ziegler to his predecessors in this field has been analogous to that of Grignard to Frankland.

This book is an item of a series—edited by H. F. Mark and E. A. Immergut—and some of the apparent gaps are (or may be) filled by other volumes in the collection. Thus Volume 2 deals with stereoregular addition polymerization which is accordingly here neglected. Similarly the oligomerization processes of butadiene, for example, will doubtless receive more attention in the future. It is a defect of this system that cognate matters are separated by a rigid adherence to the actual title.

The present Volume 12 of the series is a compendious monograph which will take its place in the literature as a standard work. It is particularly strong in dealing with the physico-chemical aspects of the subject and research workers will be very grateful for this excellent predigestion of the material scattered in the voluminous literature. Almost a third of the work is devoted to general considerations, including mechanism, and here the usual rather dogmatic classification is adopted. It is true, however, that the authors are not responsible for ideas which they reproduce.

There is no possible argument about free radical polymerization, but so-called cationic and anionic processes seem to be rather naively assumed and with little direct evidence. For example, the Ziegler–Natta polymerization of olefines is often characterized as anionic but, if that means that the unsaturated unit is attacked by an anion in the first place, the theory flies in the face of the established electron-donor character of olefines. As suggested many years ago, it is much more likely that the olefine exhibits normal nucleophilic reactivity in the first stage, followed by migration of the anionic alkyl group already combined with the metal; possibly a virtually synchronous process. However short the interval, this push–pull mechanism cannot be described as anionic.

The coverage of the book is remarkably comprehensive: radical ions, alfin catalysts, co-polymerization and polymerization of conjugated dienes are all treated in so far as organo-metallic compounds are involved.

The book, which is very well arranged and produced, can be warmly recommended to the general reader as well as to the research worker. It is indeed unique in its field and its authors have made a *tour de force* which represents a noteworthy service to the chemical community.

R. ROBINSON

# PUSHING FORWARD

## Mechanics and Chemistry of Solid Propellants

Edited by A. C. Eringen, H. Leibowitz, S. L. Koh and J. M. Crowley. (Proceedings of the Fourth Symposium on Naval Structural Mechanics held at Purdue University, Lafayette, Indiana, April 19–21, 1965.) (Office of Naval Research: Structural Mechanics Series.) Pp. xix+627. (London and New York: Pergamon Press, Ltd., 1967.) 160*s*. net.

BY bonding the solid propellant charge to the walls of the pressure vessel in which it burns, so that it can act additionally as a thermal insulator protecting its highly stressed container, rocket propulsion engineers have achieved a striking simplicity and elegance of design. Without the significant reductions in the fractional mass of inert components which the use of this technique has permitted, the greatly extended application of solid propellant rocket motors during the past fifteen years would not have been possible. Because of large and unavoidable differences between propellants and case materials in respect of thermal expansion coefficient and other physical properties, and of the wide range of temperatures in which motors may be required to function reliably, such apparent simplicity of design has added complex mechanical requirements to propellant specifications. Properties such as high performance, appropriate combustion characteristics and chemical stability must now be coupled with often conflicting attributes such as adequate extensibility and strength. These additional attributes are difficult to formulate because propellants are, of necessity, highly loaded visco-elastic materials with mechanical properties which are time and temperature dependent, non-linear, and sometimes anisotropic. They are subject, in the motor, to critical strains which may be developed in times ranging from the duration of the ignition phase, measured in milliseconds, to the period of years for which long term storage may be required. Fracture of the charge is not easily predicted in a stress field which is normally multi-axial, and its consequences may be catastrophic.

The significance of propellant mechanics is reflected by the papers in this important collection, of which only three from a total of twenty-two are concerned with chemistry as such. All the others deal in some depth with relevant problems of visco-elasticity, including material characterization, analytical techniques applicable to linear, non-linear and anisotropic materials, failure mechanisms and experimental stress and strain analysis. Each author provides an authoritative survey of part of the large and comprehensive attack which has been mounted, particularly in the United States, to elucidate such problems. Of the three papers on propellant chemistry, two discuss some implications of the relationships between combustion characteristics and mechanical