Preface

PREFACE TO THE 1ST EDITION

Everyday we are all concerned with the rheological response of a variety of materials because we have to pour, spread or reshape them. Hopefully it will be in a peaceful situation such as when we are standing on the seashore with water lapping around our feet as they gently sink into the sand and not in the situation where flows are produced by erupting volcanoes. That rheological behaviour is fundamental to our existence is clear from the way our blood flows to our very conception where the way that the flow properties of polyelectrolyte gels change with pH is a critical factor.

In the workplace, many chemists have the problem of formulating materials into a convenient form. Although we could use as an example foods, pharmaceuticals, or cleaning materials let us consider a decorative paint as an example that serves to illustrate the range of responses that we demand. The function of a paint is twofold. We wish to apply a polymer film to protect the surface that we are painting and secondly, it is a carrier for pigments to give a decorative finish. In the can we wish the pigment particles to remain suspended and to this end we produce a weak gel. A by-product of this is the nondrip behaviour. On application it must easily "thin" to be readily laid on, then we have the problem of levelling and runs prior to drying. The former is driven by surface-tension forces whilst the latter is the response to gravitational forces on the film. Hence, we require the gelation to start to reoccur but at a rate where sufficient levelling will take place. So what exactly are we asking this material to do? Firstly, it should be a soft solid that melts when we apply a force with a brush or roller, and then it must resolidify at a controlled rate. How do we achieve this? Well, not by magic, but by chemistry. We control the interactions between the molecules and the particles in the paint so that the best structure and diffusional timescales for our purposes are produced. It is the purpose of this book to clarify this process. Not just with paint of course but with any formulation.

The excitement in the study of rheology is in seeing how the timescales are so important, in seeing how our materials behave and for the chemist it is rewarding to see how the controlling factor is the same intermolecular forces that we have been trained to manipulate. Now we will have to work in terms of

stresses and strains and use some simple algebra in order to enable us to describe or predict behaviour. As this is an introductory text, derivations will only be given where they are straightforward and provide greater understanding. For more complex results, the important relationship is given and the enthusiast can find more detail from the appropriate references. The algebra is simply a compact shorthand notation that enables us to summarise the behaviour; much more important is the understanding of the mechanisms involved as it is this that gives one the ''feel'' for a subject. It is this that we wish to promote and to this end we restrict ourselves to the simple experiments that we would normally carry out in the laboratory and do not tackle the complex flows that may be important for engineering applications.

The format of the book is very straightforward. The subject with essential terminology is introduced in the first chapter. The following two chapters develop the ideas for the limiting behaviour, *i.e.* when we are not too concerned with the timescales. The next two chapters develop these ideas further as the temporal behaviour comes to the fore. Finally, we move into nonlinear behaviour. Most readers will feel right at home here as we discuss the types of experiment that they are carrying out everyday. Our aim is that every chapter should be as self-contained as possible and so we revisit basic ideas and extend them where necessary with the intention that the depth of understanding increases as the reader progresses through the book. Above all, we are interested in how atoms and molecules interact to control the handling properties of materials. Many of the systems of importance to the chemist are polymeric and particulate, and discussion of these takes up the lion's share of the volume, but it is the same forces that occur between simple molecules that we must consider in these cases too. Few undergraduate or graduate programmes have much if any discussion of rheology, polymers and colloids and we see this volume as the starting point for repairing this omission.

Jim Goodwin, Roy Hughes
November 1999

PREFACE TO THE 2ND EDITION

Since the publication of the 1st edition of Rheology for Chemists, system dimensions have become an important topic and there has been a very large expansion of publications on subjects such as microfluidics and nanoparticle systems. With decreasing size, the range and magnitude of interparticle forces become increasingly important as the separation distances frequently fall within the same range. This brings into sharp focus much of the text as we have stressed the importance of the microstructural aspects throughout the volume.

Another major change in the rheological scene since we started preparing the first edition has been the maturing of the instrumentation market. The expectation is now to be able to carry out rheological measurements as routinely and

easily as using any of the general analytical instruments. However, the interpretation of the data still requires more manipulation than, for example, calculating the relative composition of a material from an FTIR spectra. Hence, the basic toolbox provided by this volume is an important aid in handling the data successfully.

Jim Goodwin, Roy Hughes
May 2007