INTRODUCTION TO INTERFACIAL ASPECTS OF MULTICOMPONENT POLYMER MATERIALS

L. H. Sperling

Polymer Interfaces Center
Center for Polymer Science and Engineering
Materials Research Center
Department of Chemical Engineering
Department of Materials Science and Engineering
Lehigh University
Bethlehem, PA 18015-3194

ABSTRACT

This chapter introduces the interfacial aspects of multicomponent polymer materials, exploring the instruments used, the thickness of the interphases formed, and some of the more interesting results. Five kinds of surfaces and interfaces found in these materials are defined. The properties of silane coupling agents are explored. As an example of the state of the art, recent patents and literature in the field of latex blends are summarized.

INTRODUCTION

The purpose of this chapter is to provide an introduction to the interfacial aspects of multicomponent polymer materials. The basic concepts, instruments, and types of results will be summarized, along with the current status of the field. Some of the key issues and questions will also be raised. The papers that follow, based on the American Chemical Society symposium in Orlando, Florida, held under the auspices of the Polymeric Materials Science and Engineering Division, August, 1996, will delineate recent major research advances in the field.

All real materials have surfaces or interfaces. This simple statement arises from a consideration of the finite size of objects. When people speak of polymer materials, there are five basic classes of surfaces and interfaces:

1. A surface, referring to that portion of the material commonly exposed to air, that people can see and touch. Strictly speaking a surface, or free surface, refers only to a part of a clean, pure material exposed to a vacuum. However, in reality, such surfaces may be
oxidized, oily, or dirty, see Figure 1.

2. A *dilute polymer solution-colloid interface*, where polymer chains in dilute solution are partly adsorbed onto surfaces, usually colloidal. A single polymer chain may be adsorbed or bound at a number of sites, the remaining mers sticking out into the solution. Fleer, *et al.*(2) delineate the bonding and other characteristics of such polymer chains. Here, a portion of a chain lying on a solid (colloidal) surface is called a train. Several trains may be separated by portions of polymer sticking into the solution, called loops. The chain ends, which generally also stick out into the solution, are called tails.

While the two items above are not considered in detail in this edited work, there is a great deal of information to be learned from such systems. These systems are somewhat simpler than the blend and composite interfaces described below, and have been easier to treat both theoretically and experimentally.

![Figure 1](image)

**Figure 1.** Characteristic features of (a) polymer surfaces, left side, and (b) polymer interfaces, right side.

3. A *symmetric interface*, where two identical polymers are in contact, forming the interface. The healing and fracture of such symmetric polymer interfaces has been treated by Kausch(3) and Wool(4). This interface involves the contact of two melt surfaces, and is important in welding during molding operations, and in latex film formation. The interface heals with time, and disappears, as the chains on both sides intermingle via reptation motions. This interface problem, although extremely important, also will not be emphasized in this book.

4. An *asymmetric polymer interface*, involving two different polymers, Figure 1. The interface may remain indefinitely if the two polymers are immiscible with each other. Important here are the molecular weights of the two polymers, and their capability of forming entanglements with each other. Interpenetration at the interface usually ranges from a depth of a few to several nanometers, depending on how positive the free energy of mixing is. Important factors include the statistical segment length and \( \chi \). When the interface is broad, forming entanglements, the term *interphase* is commonly used. This interphase may have physical properties distinctly different from either polymer. The interphase may also contain chemical or physical bonds uniting the two surfaces, such as block or graft copolymers, or hydrogen bonds. There is growing evidence that chain ends