Chapter 1
Introduction—Human Hair, Skin, and Hair Care Products

This book presents the biophysics of human hair and hair treatment. It deals with the structure of hair, the nanomechanical characterization, nanotribological characterization, the conditioner thickness distribution and binding interactions on hair surface, and surface potential studies. It is the first book on the biophysical properties of hair.

1.1 Human Hair

Figure 1.1a shows a schematic of a human hair fiber with its various layers of cellular structure (Feughelman, 1997; Negri et al., 1993; Robbins, 1994; Zviak, 1986; Jollès et al., 1997; Smith and Swift, 2002). Hair fibers (about 50–100 μm in diameter) consist of the cuticle and cortex, and in some cases medulla in the central region. All are composed of dead cells which are mainly filled with keratin protein. Table 1.1 displays a summary of the chemical species of hair (Chen and Bhushan, 2005). Depending on its moisture content, human hair consists of approximately 65–95% keratin proteins, and the remaining constituents are water, lipids (structural and free), pigment, and trace elements. Proteins are made up of long chains of various mixtures of some 20 or 50 amino acids. Each chain takes up a helical or coiled form. Among numerous amino acids in human hair, cystine is one of the most important amino acids. Every cystine unit contains two cysteine amino acids in different chains which lie near to each other and are linked together by two sulfur atoms, forming a very strong bond known as a disulfide linkage; see Fig. 1.1b (Gray, 2003). In addition to disulfide bonds, hair is also rich in peptide bonds, and the abundant CO- and NH-groups present give rise to hydrogen bonds between groups of neighboring chain molecules. The distinct cystine content of various cellular structures of human hair results in a significant effect on their physical properties. A high cystine content corresponds to rich disulfide cross-links, leading to high mechanical properties. The species responsible for color in hair is the pigment melanin, which is located in the cortex of the hair in granular form.

An average head contains over 100,000 hair follicles, which are the cavities in the skin surface from which hair fibers grow. Each follicle grows about 20 new hair
Fig. 1.1 (a) Schematic of hair fiber structure and cuticle sublamellar structure (Robbins, 1994; Smith and Swift, 2002) and (b) various bonds within hair cellular structure (Bhushan and Chen, 2006; Gray, 2003)