Abstract

The aim of the present study is to investigate the adsorption behaviour of albumin and fibrinogen on amorphous carbon (a-C) and hydrogenated amorphous carbon (a-C:H) thin films by means of atomic force microscopy (AFM) techniques. a-C and a-C:H thin films are currently among the most frequently employed coatings for biomedical implants, and they are considered to present a host of beneficial tribological, mechanical, chemical and biological properties that render them suitable for such applications. Albumin and fibrinogen are quantitatively as well as functionally significant proteins of human blood; the preferrential adsorption of one rather than the other on surfaces is thought to suppress or augment in situ blood clotting respectively.

a-C and a-C:H thin films were developed by physical vapor deposition (PVD) and incubated with solutions of albumin or fibrinogen in phosphate buffer (PBS) for 30 minutes. Protein concentrations in the solutions ranged between 1 ng/ml and 1 mg/ml. Samples were visualised with the help of an AFM instrument operating in tapping (semi-contact) mode under ambient conditions. We examined the morphological characteristics of the protein adlayer and statistically compared the values of four roughness parameters measured for each sample. The main conclusions derived from this work are: i. The morphology and roughness of the protein adlayer formed on the films does not appear to correlate with the concentration of the corresponding protein in the incubation solution. ii. Local physicochemical or rheological factors may introduce significant variations in the appearance of the protein adlayer in different areas of the same film. iii. Albumin generally tends to adsorb in the form of circular or ellipsoidal aggregates and forms rougher adlayers; by contrast fibrinogen tends to adsorb in 'filament-like' formations and attributes an overall 'smoother' appearance to the surface of the films. iv. sp^3-rich carbon films tend to form significantly rougher albumin adlayers (and possibly accumulate greater quantities of albumin) compared to sp^2-rich films. This observation may imply better suitability of sp^3-rich films for applications where increased protein adsorption and cell integration are desirable.