Molecular dynamics study of the IgG adsorption on a graphite surface

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Abstract

Immunoglobulin G (IgG) is the most abundant of the five classes of antibodies produced by the body, and is synthesized in response to invasions by bacteria, fungi, and viruses. IgG is a protein complex composed of four peptide chains arranged in a Y-shape (see fig.): two identical heavy chains and two identical light chains of antibody monomers. A better understanding of the adsorption of the IgG to solid surfaces would have a big impact on areas ranging from medicine to biochemical engineering [1,2]. The control of the IgG adsorption, from solutions of single proteins as well as from more complex mixtures, requires an understanding of the involved mechanisms.

One adequate surface model to investigate the adsorption properties of the IgG is the graphite surface. On one hand, pyrolytic graphite is used as an implant material [2], therefore the importance of the study of the bio-compatibility with the IgG; And on the other hand, it is well established [3] that the hydrophobic nature of graphite improves the adhesion of the Fc fragment of the IgG, which is a very suitable feature for bio-sensors since they are often based on the ability of IgG to bind a large variety of molecules in a highly specific way.

In order to have a detailed understanding of the mechanisms behind the adsorption of the IgG on graphite we have performed atomistic molecular dynamics (MD) simulations using AMBER's force fields[4]. Experiments on protein adhesion typically use an AFM tip to force the protein toward the surface and then pull it of to measure force-distance curves. Therefore in this study in addition to free adsorption. Here we also report the forced adsorption of the IgG using steered MD to simulate the action of an AFM pushing the IgG towards the surface.

The level of detail on our simulations allow us to address several open questions concerning protein adsorption. In particular we are able to determine the mechanisms behind the adsorption; In which conditions the protein denature what is the role of the water molecules in such process. Moreover we were able to determine the most favorable adsorption orientation of the IgG which in turn allows us to set up a strategy to control the IgG adsorption over HOPG.

References

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Figures

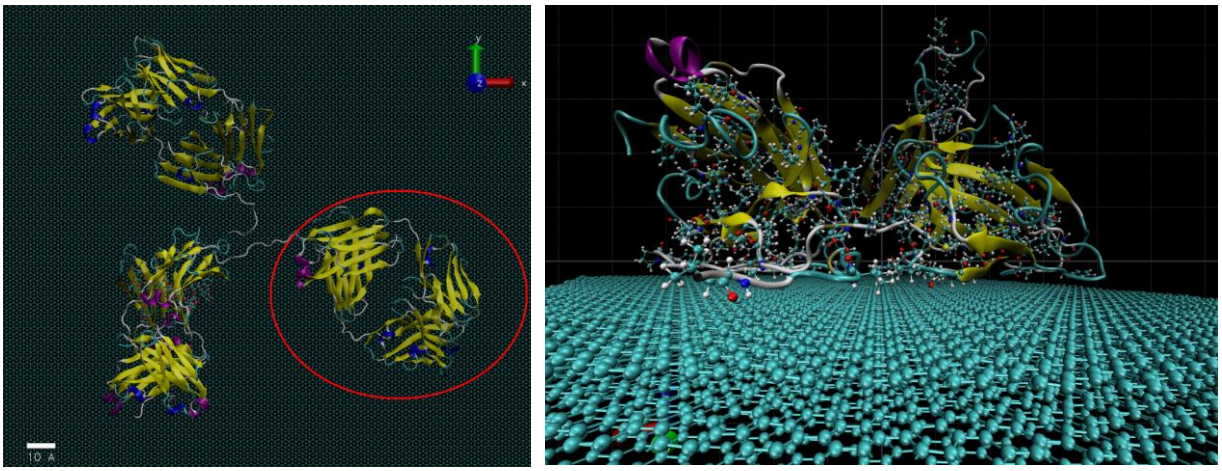

fig: (left) IgG over a HOPG graphite surface. **(right)** Adsorbed Fab (it is represented by its secondary structure,as well as by a ball-stick model for the hydrophobic residues).