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SIMPLE MODELS FOR EXTRACTING COMPRESSIVE RIGIDITY OF MOLECULES FROM ATOMIC FORCE MICROSCOPY DATA

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ABSTRACT

Atomic Force Microscopy (AFM) is a powerful method to study mechanical properties of molecules, including proteins. We describe several simple models that allow extracting the molecular mechanics from the AFM force curves. Specifically, we will show modeling self-assembled monolayers and molecular brushes on soft surfaces (like the surface of biological cells). The monolayer model will be verified for a layer of periplasmic glucose/galactose binding protein, GGRQ26C, immobilized on a gold surface [1]. Such proteins have been used as an active part of a glucose biosensor based on quartz microbalance technique. Using our model we have found that the receptor protein film immobilized on the gold surface changes its conformation and increases its rigidity when glucose is added (this resolves unexplained high sensitivity of the sensors used those proteins). Since there are a host of receptors that undergo structural change when activated by ligand, the proposed model can play a key role in the development and/or optimization of biosensors based on rigidity changes in biomolecules.

The other model is related to the molecular brushes attached to soft surfaces of biological cells [2]. We apply the method to an example of normal and malignant human cervical epithelial cells. We demonstrate that the proposed method allows to distinguish between those cell types while it is not possible just using the raw data. The derived parameters of the surface brush cannot be obtained by any other existing methods. Moreover, taking into account the presence of the brush is mandatory to derive the rigidity moduli of cell. Processing data through the model we demonstrate that on contrast to the previously reported results, malignant and normal cells do not show noticeable difference in rigidity. It is probable that the previous results might be confused with the difference in the molecular brushes on the surface of those cell types.

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