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Bending of an elastic microbeam as a result of adherent molecules

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It has been demonstrated experimentally that a relatively high density of flexible molecules end-grafted to one side of an elastic microbeam results in a measurable and reproducible curvature of the beam. The observed behavior suggests the possibility of developing easy-to-use detectors for specific molecules in solution. In the most compelling reports of the phenomenon, the experiments have been done with single-stranded DNA molecules. The magnitude of the membrane force arising from the presence of the adherent molecules which induces the curvature can be estimated from the observations. However, the molecules are not bonded to each other in any way and the physical origin of the membrane force remains obscure. The purpose here is to report on an investigation of possible origins of this force on the basis of statistical mechanics of flexible molecules. Because single-stranded DNA is very flexible, the possibility that the force derives from the increased entropic free energy of the molecular chains as a result of mutual constraint exerted by the molecules on each other once they adhere to the surface. It is found that a membrane force of the magnitude observed is readily generated in this way, but that the dependence of this force on the length of the molecules is not consistent with observations. The additional force arising from hydration interactions between the grafted molecules and the surrounding water solvent may provide an explanation for this inconsistency.

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