

Phase separation during adhesion of model cells to supported lipid bilayers

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In-depth understanding of the dynamics and kinetics of cellular adhesion is essential for a desired control and steering of a multitude of biological processes like immune responses by T cells, or tissue regeneration. Employing vesicles with their extremely simplified structure as model cells in the experiments instead of real biological cells offers the chance to reliably reveal cause-consequence relations during the adhesion process. We utilise lipid mixtures with adhesion-mediating linker molecules of two different lengths (cap-biotin and biotin-PEG) and quantitatively study the adhesion by Reflection-interference microscopy (RICM), supported by bright-field and fluorescence microscopy. Here we report on the observation of phase separation between the sub-ensembles of linker molecules. This effect is assumed to be a consequence of energy minimisation for the vesicle-substrate system. Upon slight heating the frozen phase-separated adhesion disc is stirred up, but returns to a similar segregated situation during cooling down. Whether this effect of phase segregation happens only for the case of an active cytoskeleton, is currently intensively studied by simulation. Therefore, our experimental results qualitatively improve the understanding of model-cell adhesion. However, if vesicles with a higher stiffness are employed, phase separation is hardly observable any longer. Furthermore, if the lipid mixture is used for the bilayer and not for the vesicles, the effect of phase separation is also strongly reduced, because escape of linker molecules is easier achievable in this case. In turn, linker mobility on the substrate can be switched off by observing the adhesion on an immobilised lipid layer. This highlights the crucial importance of the system parameters on the final adhesion picture.