

Mechanical state, material properties and continuous description of an epithelial tissue

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Morphogenesis of tissues involves local tissue deformation that can be quantified by the strain tensor. Using laser ablation, we sever from the surrounding tissue a disk-shaped domain larger than a cell size. This novel method allows to measure in situ the local strain tensor. Within a living epithelium in the dorsal thorax of the fruit fly pupa, we measure strain values that increase and become anisotropic during pupa metamorphosis. Analysing carefully both the immediate effect of severing, and the subsequent relaxation, we also measure the local mechanical stress tensor (up to a prefactor) and the visco-elastic time scale, of the order of tens of seconds. We further propose a spatio-temporal model of the relaxing epithelium domain. Fitting the model to experimental data, we estimate another material property of the tissue: the dimensionless ratio of external friction to internal viscosity, which decreases during metamorphosis. Good agreement with experimental data validates our description of the severed tissue domain as a linear, continuous, visco-elastic material. The method is widely applicable to provide maps of the mechanical state and material properties at different positions during the development of mono-layered epithelial tissues.