Magnetic microprobes for *in situ* mechanical testing

Master project assignment

Introduction

The extracellular matrix (ECM) is the environment for our cells. The mechanical properties of ECM influence the development of cells and tissues, and are at the same time modified by them as well. For example, cancer cells can modify their surrounding ECM to become stiffer and create spaces for their 'escape' into bloodstream so they can migrate to other places in the body. These so called metastasis events is one of the biggest reasons why cancers are lethal.

Probing the mechanical properties of the ECM in real time on local cell level can provide valuable insights of biological processes, for example cancer metastasis. However, due to the small size and low stiffness of the ECM, such probing techniques with high enough sensitivity in 3D do not exist yet.

This project will test the idea of using magnetic microparticles as probes to examine and monitor local stiffness in micrometer scale of an artificially ECM.

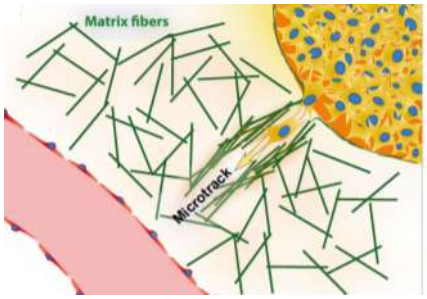

Figure 1: modification of extracellular matrix by tumor cells during cancer extravasation

Project

The way to examine the mechanical stiffness is described in Fig. 2. The deflection of pre-aligned magnetic chains of particles under certain magnetic fields can be correlate to mechanical properties of the surroundings. The project consist of two parts:

1. Embed magnetic particles in a suitable artificial ECM (similar stiffness to the real ECM) and pre-align them in a homogeneous magnetic field; good particle attachment to the matrix, densities and distribution of particles and the chain length needs to be optimized;

2. Apply deflection torques to the magnetic particle chains by changing the direction of the external magnetic field and correlate the deflection values to the stiffness of the artificial ECM (separately measured using bulk techniques); the influence of actuation field strength and direction, static vs. dynamic and create model for this method are the key study points in this step.

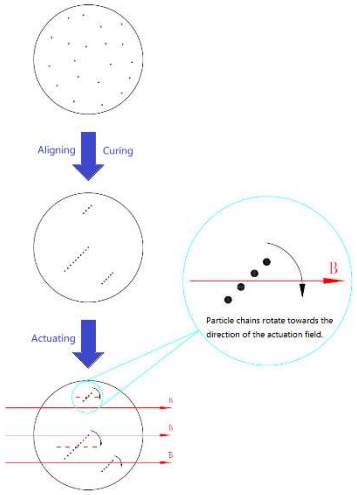

Figure 2: embedding magnetic particles in an artificial ECM and applying mechanical stimuli by external magnetic field.

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