Rigidity-matching between cells and the extracellular matrix leads to the stabilization of cardiac conduction

Marcel Hörning
Department of Physics Graduate School of Science Kyoto University, Japan

Satoru Kidoaki
Division of Biomolecular Chemistry Institute for Materials Chemistry and Engineering Kyushu University, Fukuoka, Japan

Takahito Kawano
Division of Biomolecular Chemistry Institute for Materials Chemistry and Engineering Kyushu University, Fukuoka, Japan

Kenichi Yoshikawa[1]
Department of Physics Graduate School of Science Kyoto University, Japan

[1]Department of Physics, Graduate School of Science, Kyoto University, Kyoto, Kyoto 606-8502, Japan, Tel.:(0081)75-753-3812, Fax:(0081)75-753-3779

SUPPLEMENTAL MATERIAL

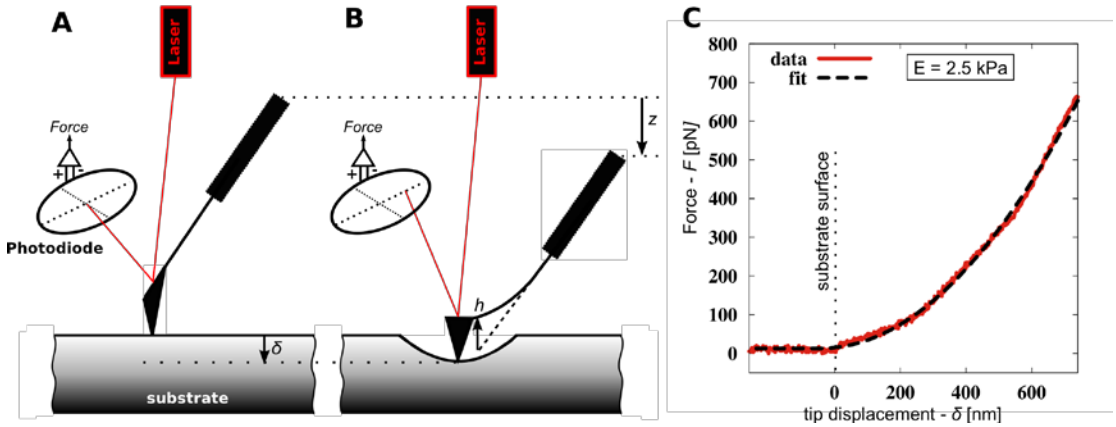

Figure S1: Schematic description of indentation-force measurement with atomic force microscope (AFM). The sample is fixed on the bottom and in the observation medium. The laser beam reflected by the cantilever that is controlled by the AFM scanner is measured by a photodiode. The cantilever deforms when it touches the substrate and the laser beam changes its relative position on the photodiode, which causes a change of photo cur- rent as detected by the photodiode. Thus, the specific force-response curve can be obtained to evaluate the rigidity of the substrate. A and B show a sketch of the laser beam before and after indentation, respectively. C shows an example of a measured force curve in respect to the tip displacement that corresponds to 2.5kPa-rigidity gel substrate. The rigidity is obtained by nonlinear least squares fitting to the Hertz model considering the case of a conical indenter (see also Methods in the main article).

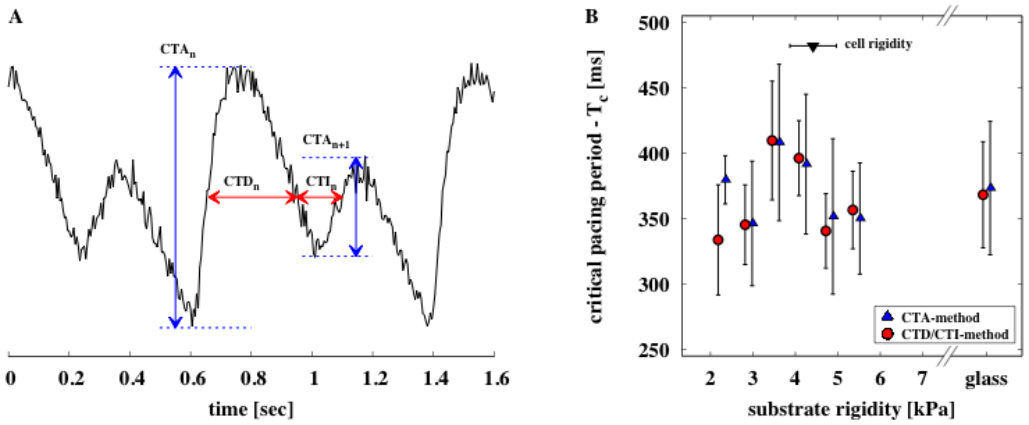

Figure S2: Critical pacing period of cytosolic calcium alternans determined by cytosolic transient amplitude (CTA) and cytosolic transient duration/interval (CTD/CTI). A shows a typical single pixel recorded cytosolic calcium signal of high-frequency paced waves and the definition for CTA, CTD and CTI. CTD and CTI are determined by considering the intensity threshold at 50%. The critical pacing period to induce alternans is determined similarly for both methods as described in the article, where the ratio of CTA_n to CTA_{n+1} and CTD_n to CTI_n was used, respectively. B shows the critical pacing period (T_c) for both methods in respect to the substrate rigidity. T_c is obtained when subsequent waves n and n+1 exhibited constant switching between high and low ratios of CTA_n/CTA_{n+1} and CTA_{n+1}/CTD_n, respectively. The change of the variance of the ratios is used to determine T_c for each experimental sample (see also Fig. 4C). Larger pacing periods that did not show alternans exhibited a constant low variance, whereas the variance increased when alternans occurred.

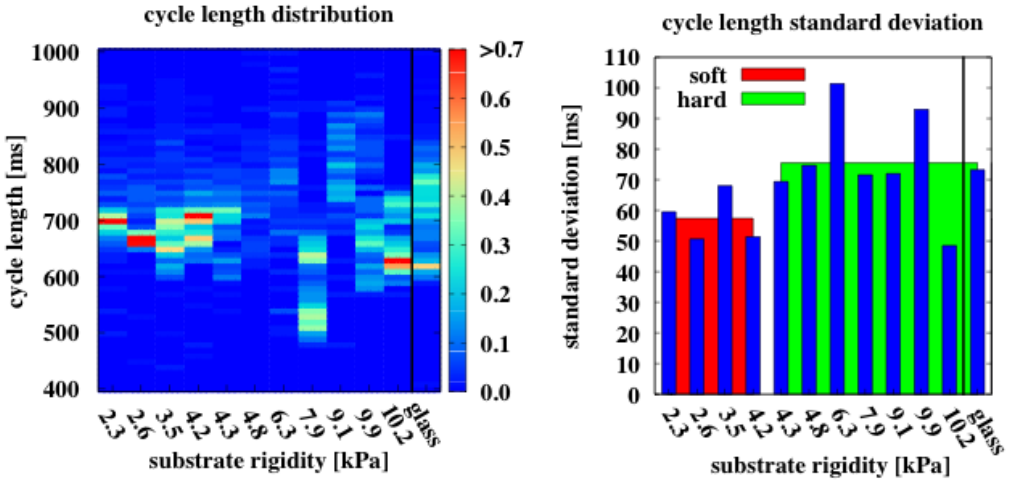

Figure S3: Cycle length (CL) distribution and standard deviation of spontaneous beating cardiac tissue on different substrate rigidities. A shows the CL distribution that is obtained considering the intensity threshold at 50% similarly as shown exemplarily for the CTD and CTI in Fig. S2, where CL is defined as the sum of both (CL=CTD+CTI). B shows the CL standard deviation of each CL distribution that is shown in A depending on the substrate rigidity with blue bars. Red and green bars illustrate the standard deviation for the CL distribution for soft and hard tissue that corresponds to the CL histogram in Fig. 3C.