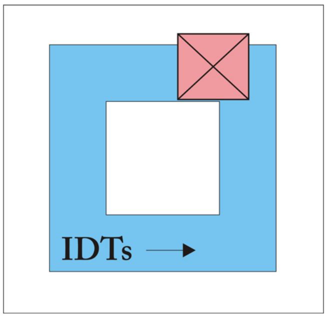
An Acoustically-Driven Biochip – Impact of Flow on the Cell-Association of Targeted Drug Carriers

Christian Fillafer, Gerda Ratzinger, Jürgen Neumann, Zeno Guttenberg, Silke Dissauer, Irene K. Lichtscheidl, Michael Wirth, Franz Gabor, Matthias F. Schneider*

Video S1. Variation of the fluid flow velocity in a 3D-microchannel by controlling the input power of the SAW-pump. Fluorescence labelled polystyrene beads (3 µm, Polysciences Inc., Germany) were used as indicators of flow. Observation with a Nikon Labophot microscope (magnification 2x) equipped with a low light sensitive video camera (Photonic Science); recording on digital video tape (Sony).

Position of the IDTs and the location for video recording in the 3D-microchannel:



Video S2. Generation of constant and pulsating fluid flow in a 3D-microchannel by amplitude modulation of the high frequency signal. No modulation ("no pulse"), modulation of the signal amplitude with 0.5 Hz ("pulse frequency: 30 min^{-1}), 1 Hz ("pulse frequency: 60 min^{-1}) and 2 Hz ("pulse frequency: 120 min^{-1}). Fluorescence labelled polystyrene beads (3 µm, Polysciences Inc., Germany) were used as indicators of flow. Observation with a Nikon Labophot microscope (magnification 4x) equipped with a low light sensitive video camera (Photonic Science); recording on digital video tape (Sony).

Position of the IDTs and the location for video recording in the 3D-microchannel:

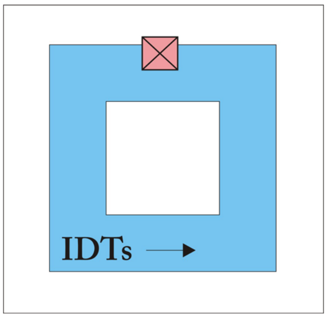


Figure S3. Acoustically-driven biochip and 3D-microchannel. Surface acoustic wave (SAW) pump consisting of the high frequency connector (HF-input) and piezoelectric substrate (PES) with interdigital transudercs (IDTs).

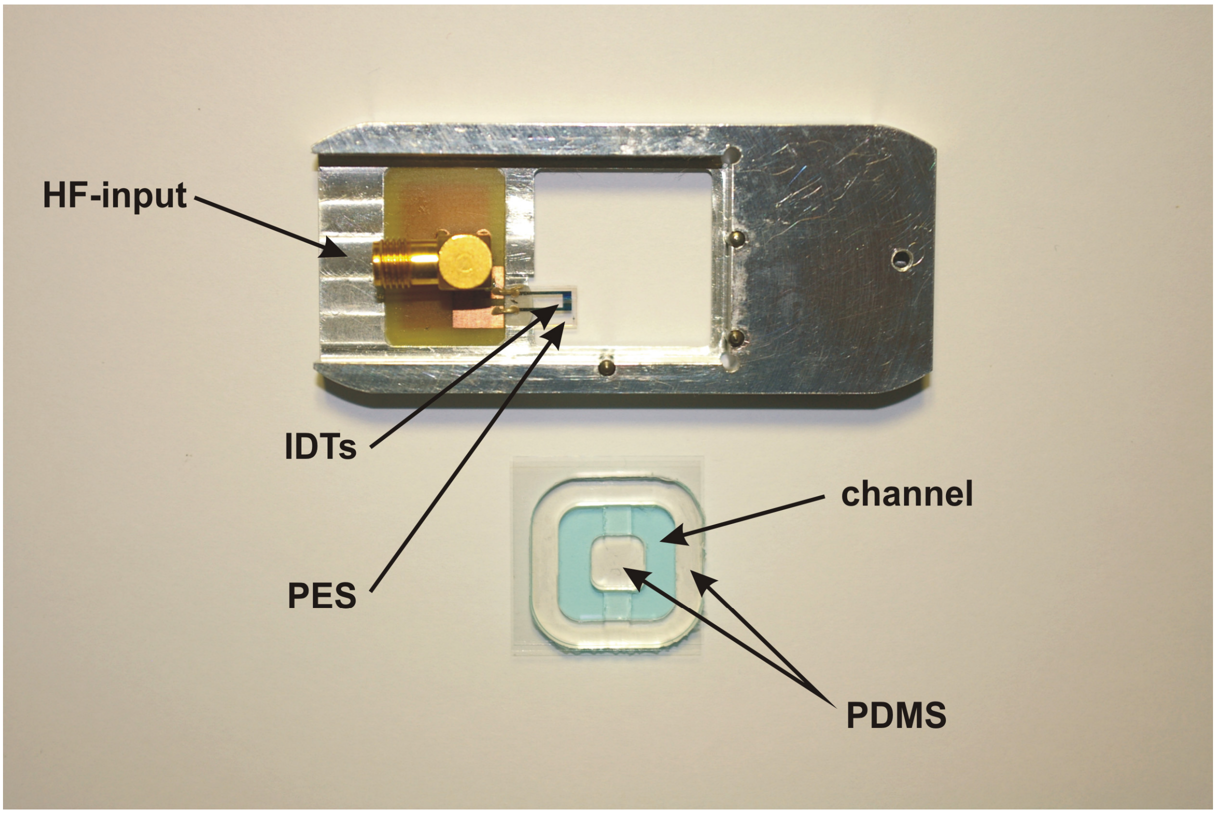
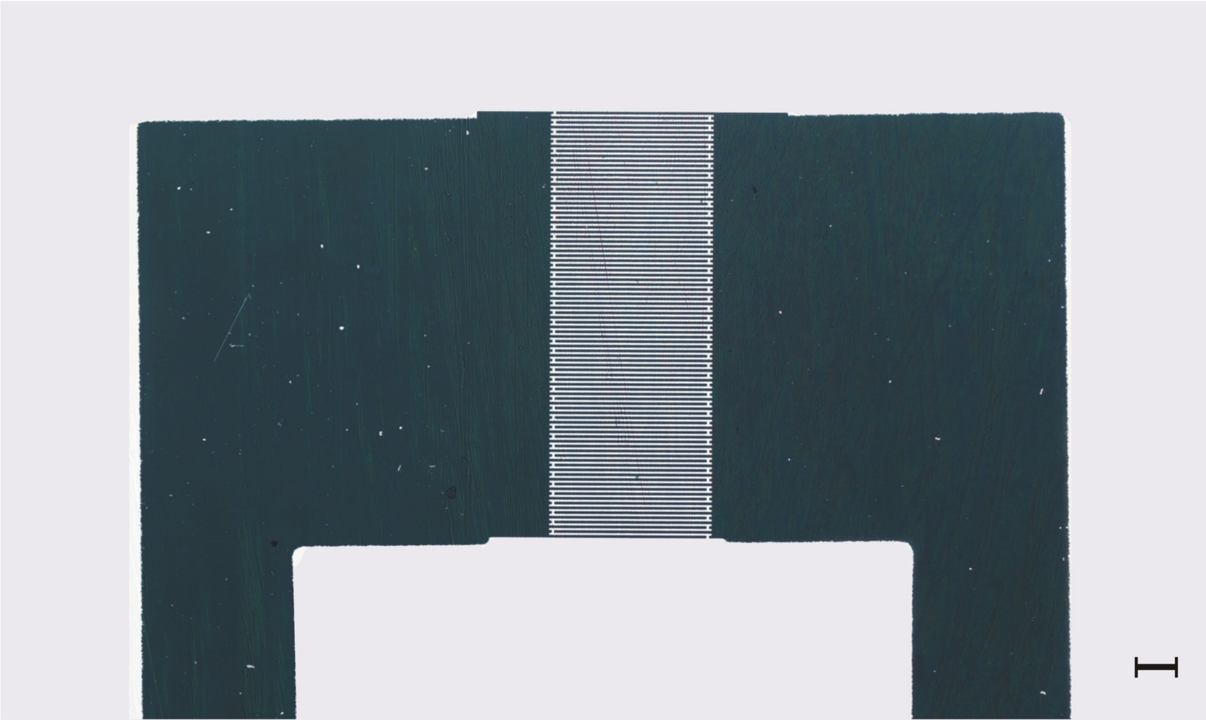


Figure S4. Interdigital transducers (IDTs). Bar represents 100 μm.



Calculation S5. Calculation of sedimentation rate

The calculation of the critical height z_{crit} for particle sedimentation is based on a parabolic flow velocity profile $v_x(z)$ (1) which is justified by numerical simulation.

$$v_x(z) = a \cdot z^2 + b \cdot z + c \qquad (1)$$

The sedimentation of a microparticle is primarily affected by gravity. Stoke's law leads to a constant sedimentation velocity v_{sed} which leads to a linear diminution of the particles z-position in the 3D-microchannel (2).

$$z(t) = z_0 - v_{sed} \cdot t \qquad (2)$$

Upon substitution of z in (1) with $z(t)$, an expression $v_x(z_0;t)$ is obtained. Time integration from zero to τ leads to (3) with $\alpha = av_{sed}^2$, $\beta = 2az_0v_{sed} + bv_{sed}$, $\gamma = bz_0 + c + az_0^2$.

$$x(\tau) = \frac{\alpha}{3}\tau^3 + \frac{\beta}{2}\tau^2 + \gamma\tau \qquad (3)$$

When a particle is deposited on the surface at time τ, $z(\tau)$ (2) will be zero. Shifting round, we can substitue τ with z_0 / v_{sed}. Since it is assumed that the SAW leads to a homogeneous redistribution of the microparticles near the IDTs, sedimentation has to occur within one cycle corresponding to the length of the channel L. Therefore, a third order equation for z_0 has to be solved which leads to the critical height z_{crit}. It turns out that the number of deposited particles should be independent from the maximum value of v_x. This estimation is only valid, as long as z_{crit} is below half the height of the channel.