Tunning surface-surface interaction Ultrasound radiation by using a non-invasive method

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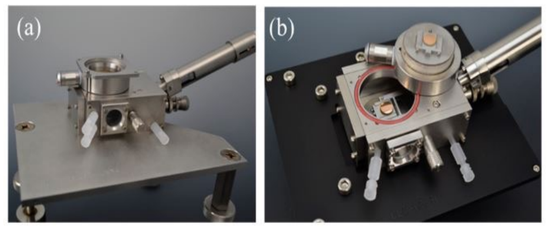
Introduction

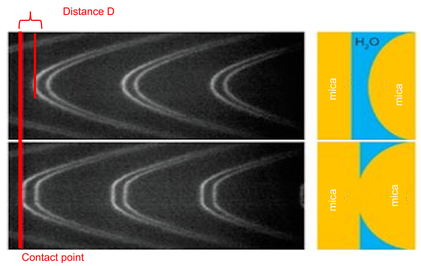
Understanding the surface-surface cell interactions or cell interaction with extracellular environment such as cell-proteins interactions is major factor to know the function of living organs. Controlling the underlying mechanism of cell-surfaces interactions at interfaces is one of most demanding aim for a range of scientific fields and applications in the diagnostic microarrays, biosensing, drug delivery and regenerative medicine [1,2]. For decades ultrasound (US) used in medical diagnosis and imaging [3], enhancing the efficacy of many treatments and drug delivery [4] even tribology [5]. But knowing the effect of US on surface interactions (adhesin, lubrication) are poorly investigated. Our hypothesis is that controlled amount of ultrasound radiation will manipulate the surface-surface interactions from adhesive (which is essential for capture) to repulsive (which facilitates evasion and penetration).

Methods

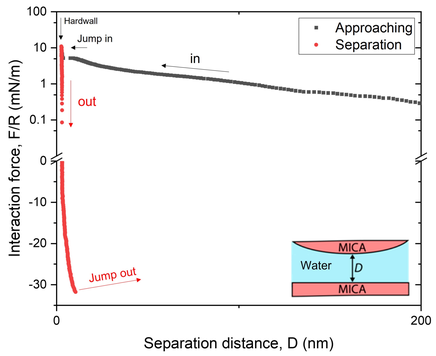
The experiments performed using the surface forces apparatus (SFA), allowing to quantitatively measure interaction forces between two surfaces in presence of external stimuli such as ultrasound (US) to evaluate the impact of ultrasounds on the interaction forces between surfaces to identify the key parameters that can eliminate any possible adhesive.

When the white light passes through the mounted surfaces, the solver layers of opposing surfaces act as an optical trap, providing an interference pattern known as fringes at equal chromatic order (FECO).





Results

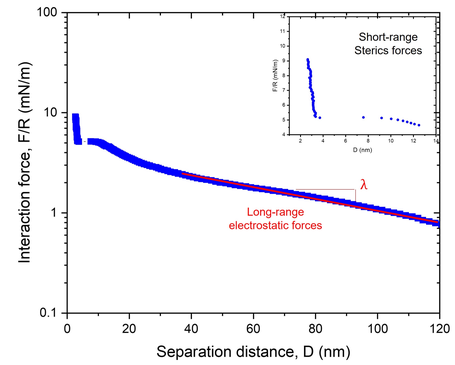


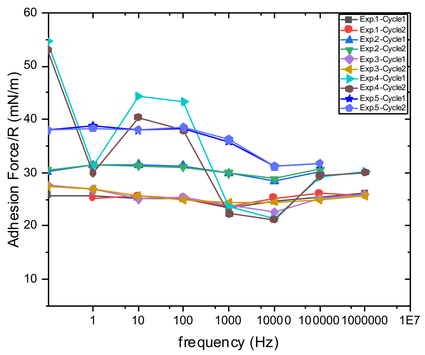
Normal force profile for approaching and separation of surfaces.

- The filled black points are measured during approach while the filled red points are measured during separation.

Typical interaction force profile

- Long-range electrostatic interaction exponential decay as $F/R \sim \exp(-\lambda^{-1}D)$.
- Characteristic Debye length λ equals 50 nm.





Adhesion forces in different frequencies

- Minimum adhesion was observed from 1kHz to 10kHz.

$$F_{Adhesion} = K\Delta D_{jump}$$

Conclusions

Our results showed that controlled amount of ultrasound radiations, including amplitude and frequency as tunning parameters, modulate surface-surface interactions. Specifically, we observed that ultrasound radiation transfers the state of surface-surface interaction from adhesive to repulsive, a promising result toward the application of ultrasound in modulating cell-cell membrane interactions.

References

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