http://www.diva-portal.org

Postprint

This is the accepted version of a paper presented at *20th International Conference on Miniaturised Systems for Chemistry and Life Sciences (μTAS 2016), Dublin, Ireland, October 9-13 2016*.

Citation for the original published paper:

Fornell, A., Garofalo, F., Nilsson, J., Tenje, M. (2016)
Experimental investigation of resonance conditions for particle focusing in droplet acoustofluidics.
In:

N.B. When citing this work, cite the original published paper.

Permanent link to this version:
http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-309850

RESULTS AND DISCUSSION

In the experiments, acoustic particle manipulation was observed in all systems. The strongest and most stable focusing was observed in the olive oil system, while focusing was weaker in the other systems (fig. 3). The droplet length varies, as this is related to the fluid properties in the system. Even with shorter water droplets in HFE-7500, particle focusing is weak (data not shown), indicating that the acoustic mismatch and not the droplet length is the reason. Further, we have achieved good focusing of particles in a channel filled with HFE-7500 only, showing that the acoustic mismatch between the phases and not the oil itself is the reason for the weak focusing (data not shown).

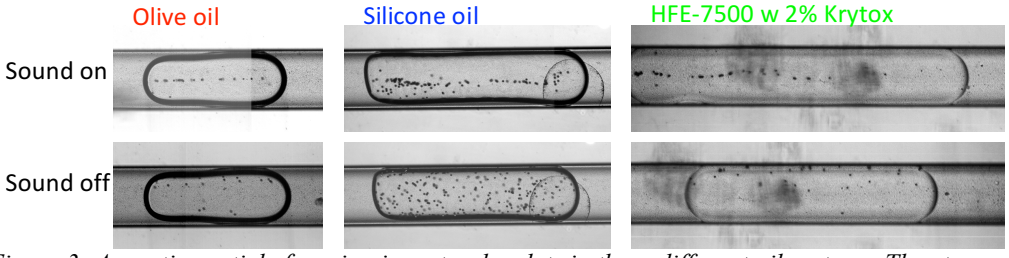

Figure 3: Acoustic particle focusing in water droplets in three different oil systems. The strongest focusing was seen in the olive oil system, while it was weaker in the silicone oil and HFE-7500 systems.

The simulations confirm that the acoustic force on a particle is highest in the acoustically matched system (water/olive oil), and lower in the other systems (fig. 4). The experimentally observed frequencies for particle focusing and the calculated frequencies are shown in table 2. Experimentally, the frequency range for good focusing around the resonance frequency was much wider in the olive oil system, indicating a more robust system.

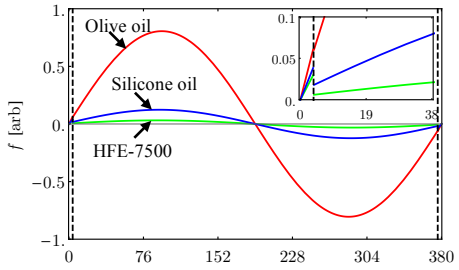

Table 2. Experimental and simulated resonance frequencies in three-layered systems

System	f_{exp} [MHz]	f_{sim} [MHz]
Olive oil	1.75-2.20	1.96
Silicone oil	1.75	1.91
HFE-7500 w 2% Krytox	1.70	1.88

Figure 4: The computed acoustic force in three-layered systems. The dashed line indicates the oil/water/oil interface. The force is highest in the olive oil system and lower in the other systems. The inset shows a discontinuity in the force at the fluid interface that arises due to the difference in acoustic properties of the fluids.

CONCLUSION

Our results show, both experimentally and theoretically, that acoustic matching between phases in layered systems is required to achieve strong resonance. This understanding will enable the design of optimal systems for combining acoustic focusing with droplet microfluidics.

ACKNOWLEDGEMENTS

This work was founded by the Crafoord Foundation, the Swedish Research Council, Knut and Alice Wallenberg Foundation (Grant No. KAW 2012.0023), and Längmanska kulturfonden.

REFERENCES

[1] A. Lenshof, C. Magnusson, T. Laurell, "Acoustofluidics 8: applications of acoustophoresis in continuous flow microsystems," *Lab Chip*, 12, 1210–1223, 2012.

[2] A. Fornell, H.N. Joensson, M. Antfolk, J. Nilsson, M. Tenje, "Focusing microparticles inside droplets using acoustics," *ICU International Congress on Ultrasonics*, 2015.

[3] A. Fornell, J. Nilsson, L. Jonsson, P.K. Periyannan Rajeswari, H.N. Joensson, M. Tenje, "Controlled Lateral Positioning of Microparticles Inside Droplets Using Acoustophoresis," *Anal Chem*., 87, 10521–10526, 2015.

[4] M. Settnes, H. Bruus, "Forces acting on a small particle in an acoustical field in a viscous fluid," *Phys Rev E,* 85, 1–12, 2012.

CONTACT

* A. Fornell; phone: +46-46-2227527; anna.fornell@bme.lth.se