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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).

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

<table>
<thead>
<tr>
<th>System</th>
<th>$f_{exp}$ [MHz]</th>
<th>$f_{sim}$ [MHz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil</td>
<td>1.75–2.20</td>
<td>1.96</td>
</tr>
<tr>
<td>Silicone oil</td>
<td>1.75</td>
<td>1.91</td>
</tr>
<tr>
<td>HFE-7500 w 2% Krytox</td>
<td>1.70</td>
<td>1.88</td>
</tr>
</tbody>
</table>

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.

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REFERENCES


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