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Thermal dielectrophoretic force on a dielectric particle
BARUKYAH SHAPARENKO, HOWARD HU, HAIM BAU, University of Pennsylvania — A particle immersed in a fluid subjected simultaneously to electric and thermal fields experiences an electrostatic force given by not only classical dielectrophoresis (DEP), but also an additional force, which we term thermal DEP. Assuming the change in the background electric field across the particle and the relative change of temperature-dependent electric properties across the particle are both small, we develop a linearized model to solve the electric field analytically and integrate the Maxwell stress tensor to find an expression for the thermal DEP force for aligned electric and thermal fields. This thermal DEP force is proportional to the temperature gradient, the square of the electric field strength, and the particle's volume. We compute the fully-coupled system in COMSOL to determine a range of validity for our linearized model and show a practical way to superimpose the classical DEP and thermal DEP forces to find the total electrostatic force on the particle relative to the fluid. Additionally, we examine the thermal DEP force and torque on the particle for unaligned fields. Due to the high electrical conductivity of common biological buffers, the thermal DEP force can play an important role when an electric field is used to control and manipulate cells or bacteria.

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