Force on a Dielectric Medium in an Electrostatic Field

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When a high dc voltage is applied on an asymmetric capacitor, there will be a net force directed toward the smaller electrode of an asymmetric capacitor irrelevant to the polarity, such phenomenon is called the Biefeld-Brown effect. Today, the physical basis of this effect is still not well understood and further exploration is needed. By understanding the physical origination of this thrust, the Biefeld-Brown effect may find applications on aircraft and vehicle propulsion in the future.

Many experiments have shown that the effect is strongly related to the medium and claimed nothing but of ionic wind and conservation of momentum. In this work, we first use the ionic model to determine the force on the asymmetric capacitor, and then discover that the force may be of few orders too small. Next, we constructed a model combining Maxwells stress and the thermodynamic free energy of nonlinear dielectric fluid under high electrostatic field. The resultant thrust on the asymmetric capacitor is related to the air pressure, the gradient of dielectric constant, the gradient of the square of the electric field, and so on. The nonlinearity of the dielectric medium has been treated with microscopic model and with statistical method to determine the field-dependent dielectric constant.

Field distribution with closed form of a canonical structure can be derived. The force without ionic wind has been calculated. Future work is on going to construct a better model on the field-dependent dielectric constant based on thermodynamic free energy.