

Re: Capacitor and Force

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Heres the problem, due to John Perry.

My assumption about ceramic caps was wrong. I didn't know it was layered.

Since one has layers the charge is distributed between each layer. Suppose there are $2n$ interleaved layers and charge Q . Then each layer has charge Q/n . Every layer experiences a force between every other but almost all cancel out.

By assuming all the charge Q was on just one plate seperated by a distance r was wrong(Which is how jus 2 plates would actually work).

Some initial investigation shows that the layers have a significant effect in reducing the force. No only is the charge on each plate reduced by Q/n but the distance between the first and last is increased because of all the layers inbetween. So treating a ceramic cap as a parallel plate cap is wrong as I did it. (using CV to get the charge and assuming it was on each plate because it should be Q/n but I have no idea what n is).

So there are forces there but they are much smaller than what I was thinking. For a very large parallel plate cap one has $C = \epsilon A/d$, $Q = C*V$, $F = k*(Q/d)^2 = k*(\epsilon A/d*V/d)^2 = k*(\epsilon A*V/d^2)^2$.

For $A = 1/4 \text{ m}^2$, $V = 10\text{V}$, $d = 1\text{mm}$, one gets $F = 4\text{N}$. This is without a dielectric in a vacuum. I imagine that that if one inserts a dielectric(which they will probably have to if they want to insulate it) that it will cut the charge in half because the dielectric sorta acts as a layer itself. In any case it should be an order of magnitude approximation.

Note that increasing $d = 2\text{mm}$ gives $F = 0.2\text{N}$ so the F is heavily dependent on d . (obviously it is d^{-4}). Changing d by a factor of 10 changes F by a factor of 10000.

Jon

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