Surface impedance of thin films

Definition

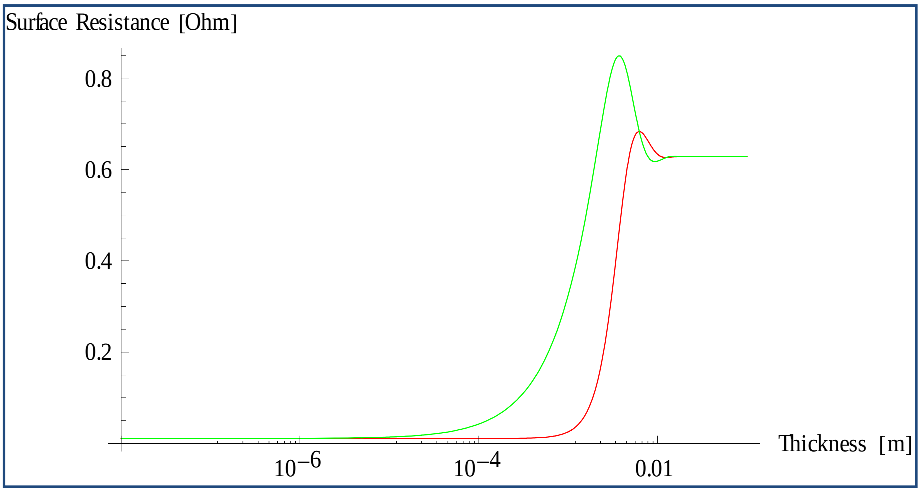
The measured electrical resistance of our a-C films is $2.5*10^5$ μOhm.cm. The surface impedance calculations are done assuming $\varepsilon=\varepsilon_0$.

The film is deposited on stainless steel which has a resistivity of 75 μOhm.cm. The frequency of the calculation is 40 MHz (arbitrary). All values reported are in MKS units.

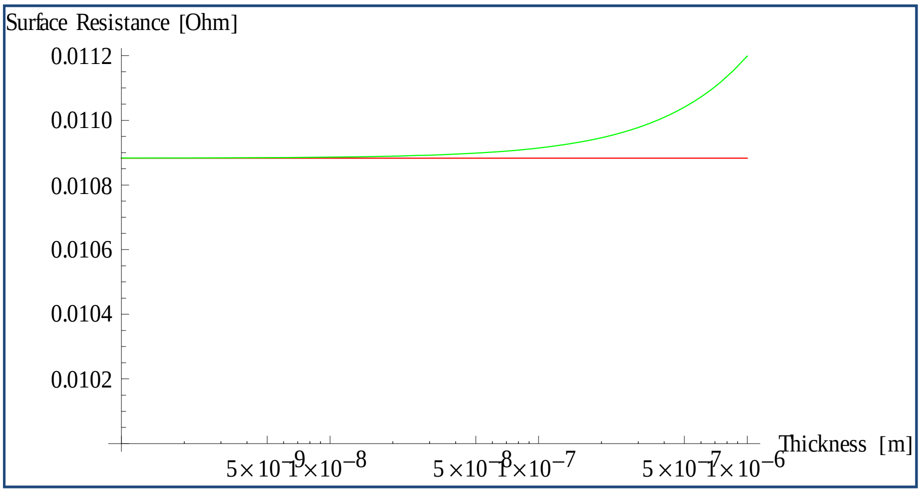
Calculations

Surface resistance as a function of thickness

This plot gives the surface impedance of an a-C film deposited on stainless steel, as a function of its thickness. Red is real part, green is imaginary part.



Same, but zoomed at small thickness (note the different resistance scale):



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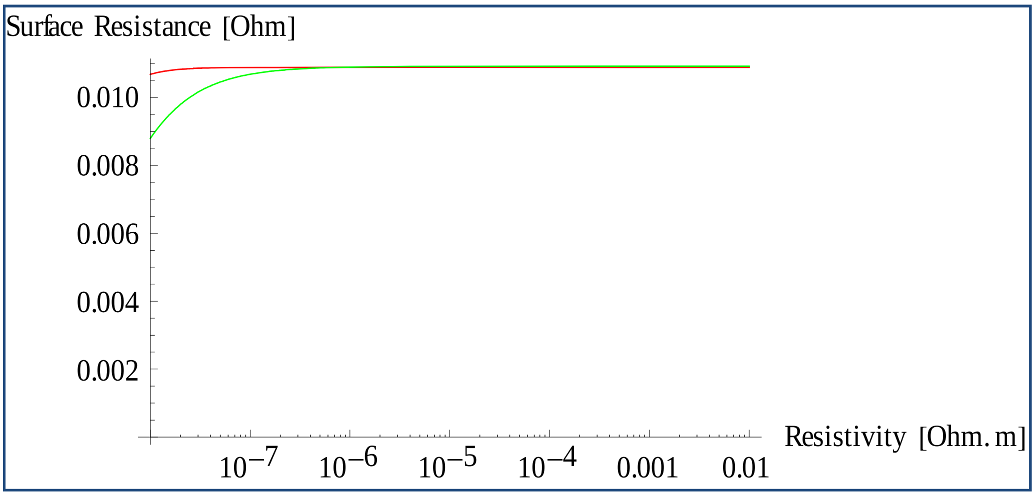
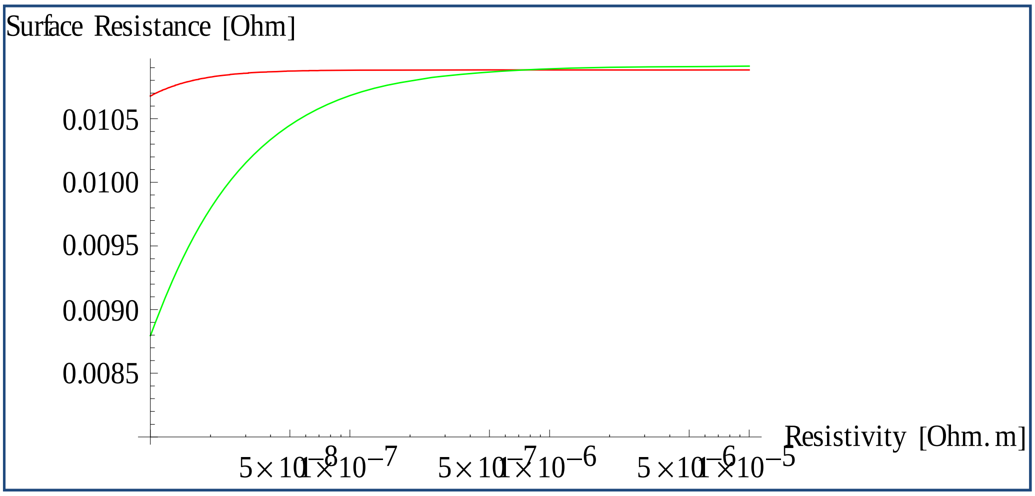
Conclusion: a-C is practically transparent for thickness < 1 µm and it has the surface impedance of stainless steel (0.01088 Ohm). At very large thickness (> 1 cm) it stabilizes to its own surface impedance.

Surface resistance as a function of resistivity

This plot gives the surface impedance of a film 100 nm thick and variable resistivity deposited on stainless steel. Red is real part, green is imaginary part.



Same, but zoomed at low resistivity:



Conclusion: a film of 100 nm thickness deposited on stainless steel is practically transparent if it has a resistivity larger than that of stainless steel

Note: the calculation has been repeated assuming the relative dielectric constant ε_r equal to the graphite value of 5.4, considered as a reasonable benchmark. This gives results indistinguishable from ε_r=1, since at these low frequencies the propagation coefficient *k* is dominated by conductivity. (The dielectric (real) and conductive (imaginary) part of *k* become of comparable magnitude only at about 40 THz.)

To be done: Frequency change (3D plots?)

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