Should MAC Be the Only Item on the Menu?

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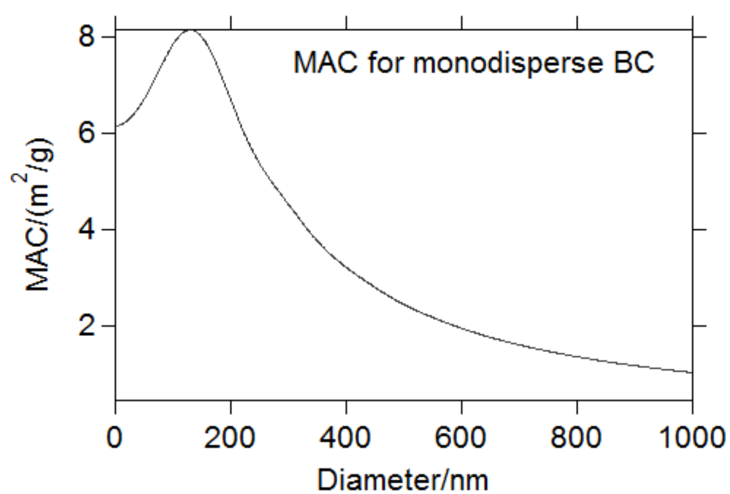
MAC: Mass Absorbance Cross Section

$$\mathrm{MAC} = \frac{\sigma_{\mathrm{ABS}}}{\mathrm{BC\ Mass}}$$

For a homogeneous BC sphere: $\sigma_{\mathrm{ABS}} = \frac{\pi}{4} D_{\mathrm{tot}}{}^{2} Q_{\mathrm{ABS}}\left(D_{\mathrm{tot}}/\lambda, m\right)$

Therefore: $\mathrm{MAC} = \frac{3Q_{\mathrm{ABS}}\left(D_{\mathrm{tot}}/\lambda, m\right)}{2D_{\mathrm{BC}}\rho}$.



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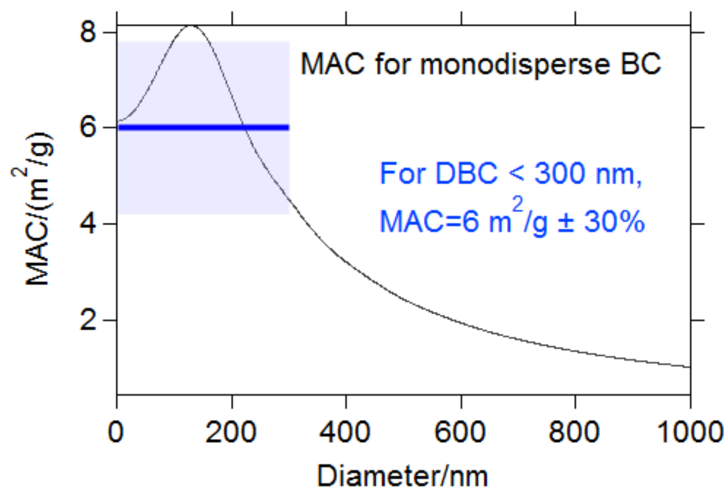
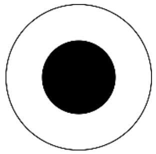
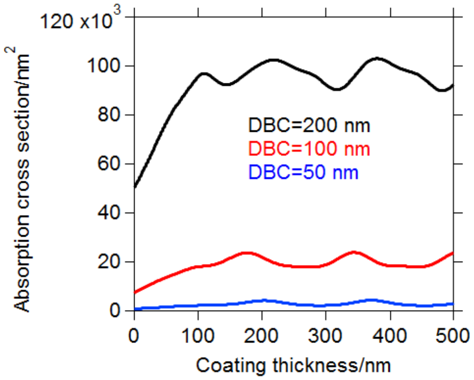


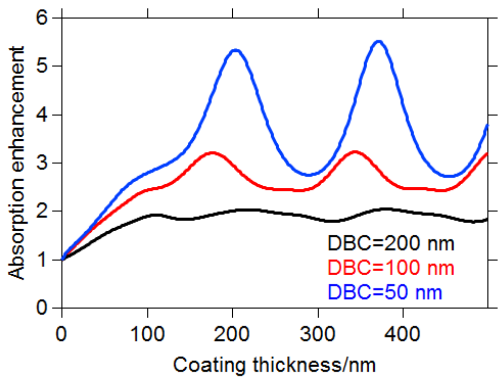
MAC(BC) = 6 $m^2/g \pm$ 30% for D(BC) < 300 nm.

MAC allows absorption to be determined from BC mass (assuming only BC absorbs!).

Coated Sphere with Non-absorbing Coating







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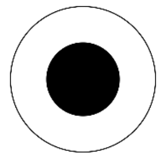

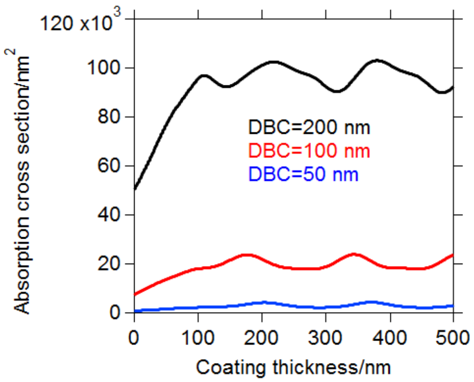

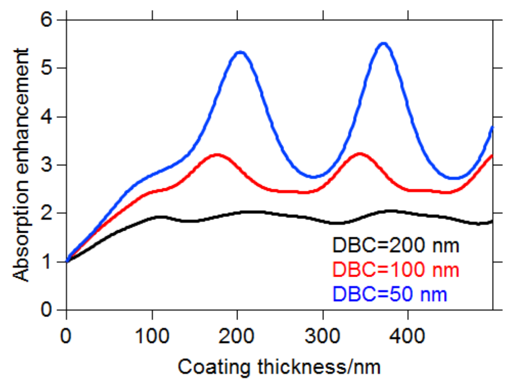

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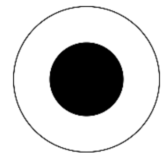

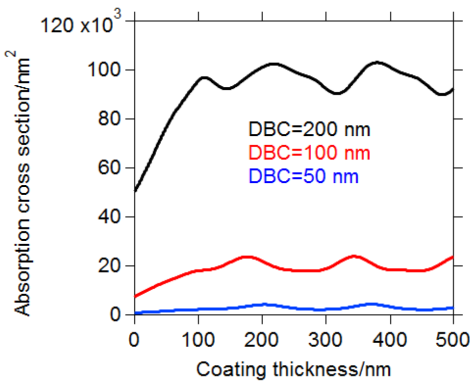

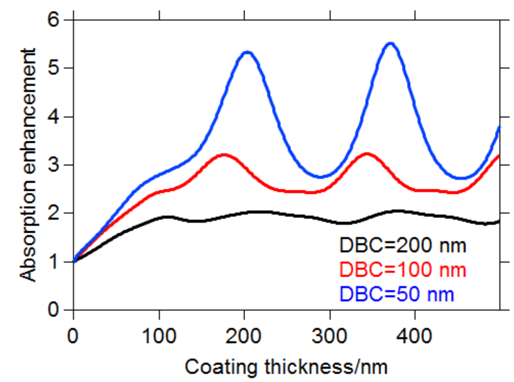

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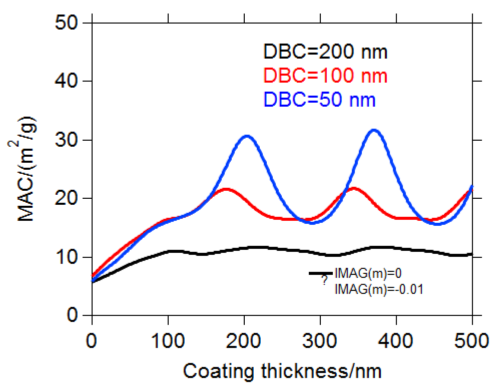

MAC behaves like Absorption Enhancement for given core diameter.

Absorption Enhancement

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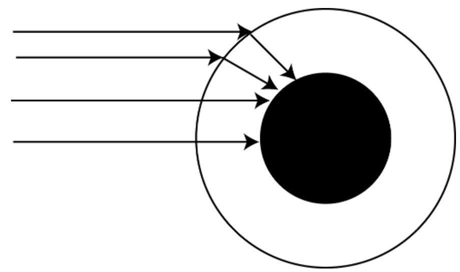
The argument typically presented is that enhancement is caused by "lensing," in which refraction causes more photons to hit the core.



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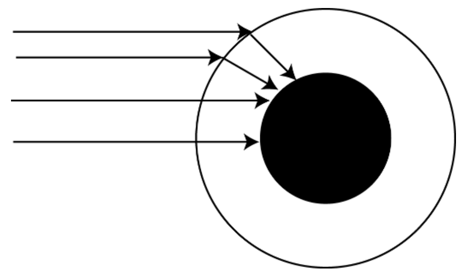

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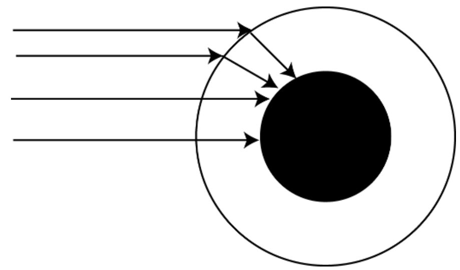

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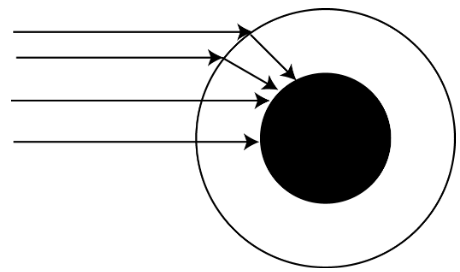

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For λ=500 nm and m=1.4, $Q_{SCA}(D$ =100 nm) = 0.024, whereas $Q_{SCA}(D$ =400 nm) = 1.74.

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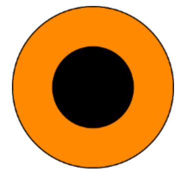

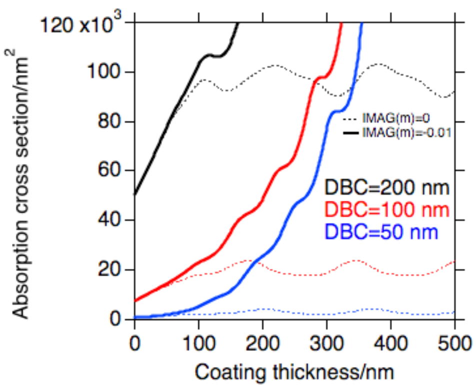

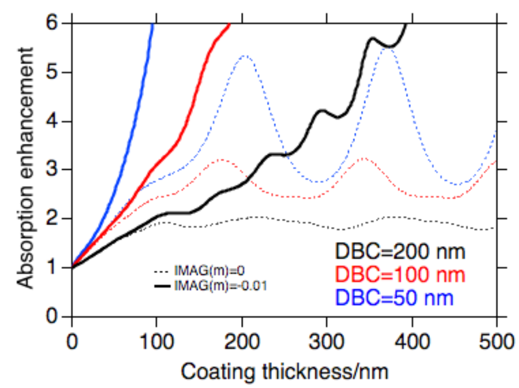

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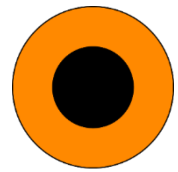

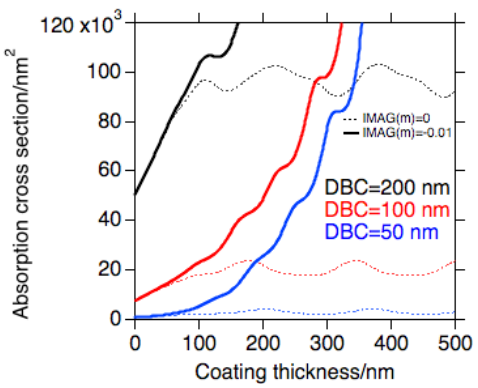

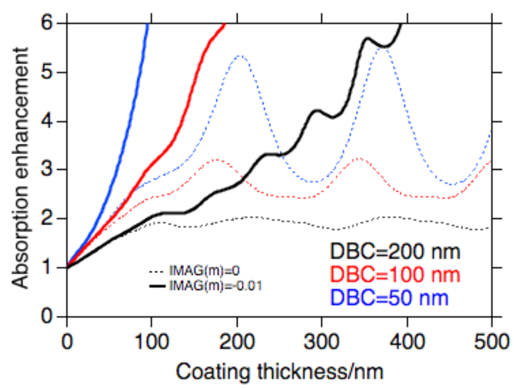

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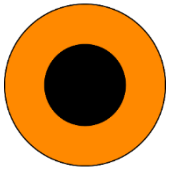

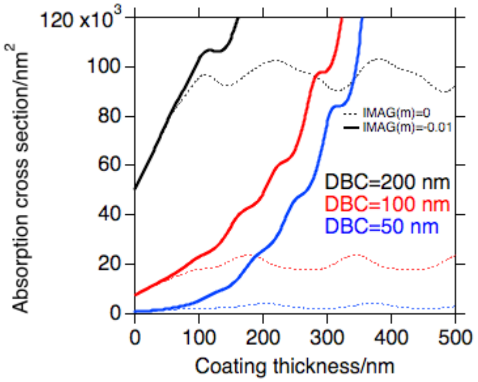

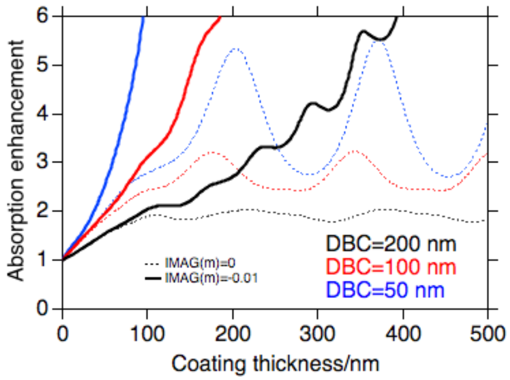

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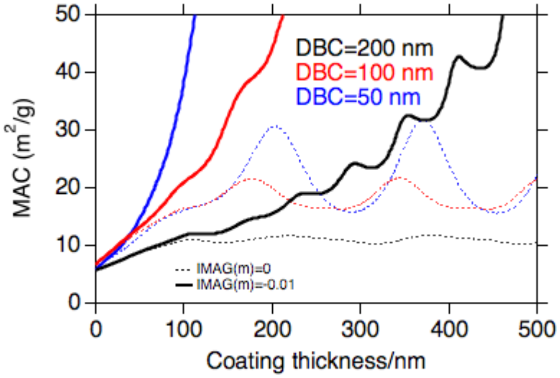

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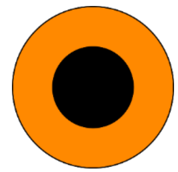

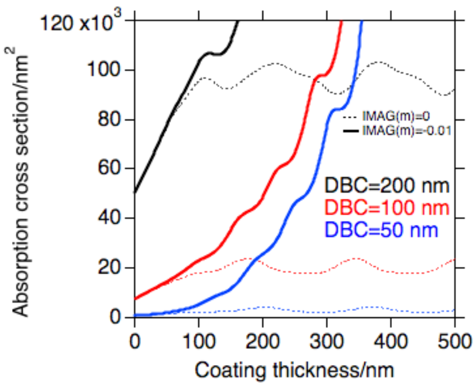

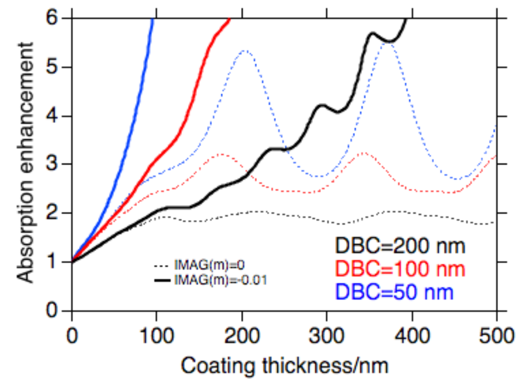

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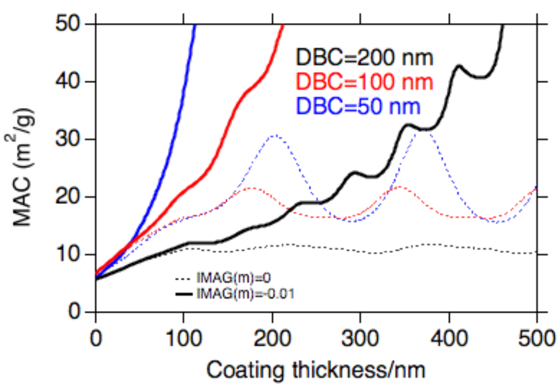

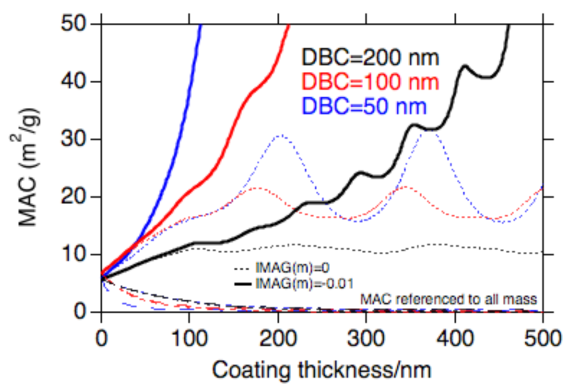

MAC behaves like Absorption Enhancement for given core diameter.
MAC referenced to total mass drops off rapidly with increasing coating.

Coated Sphere with a Hygroscopic Coating

For fixed core diameter and constant coating mass, with hygroscopic coating, increasing RH results in a larger coating.

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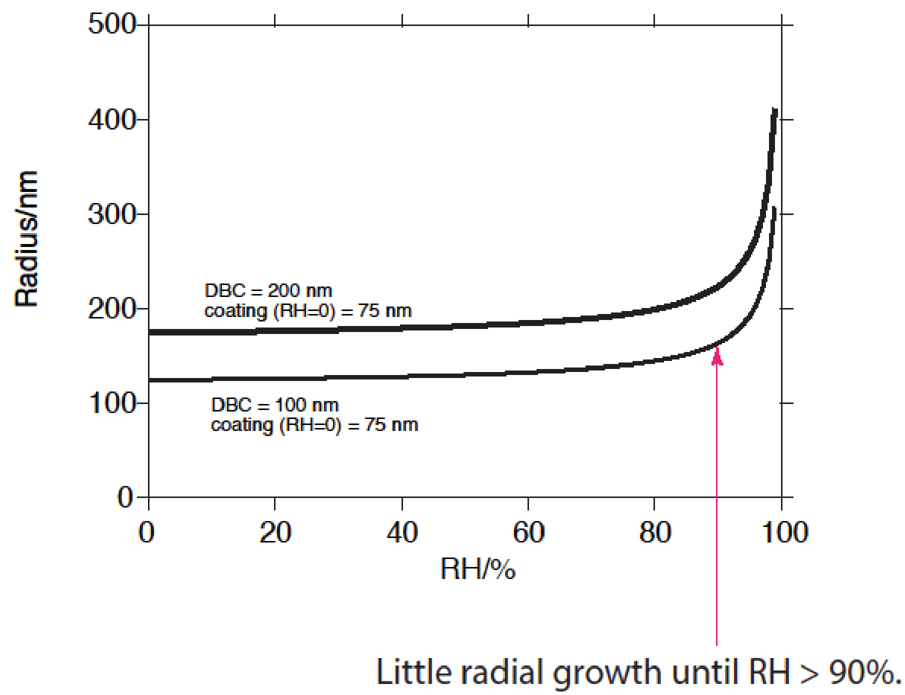

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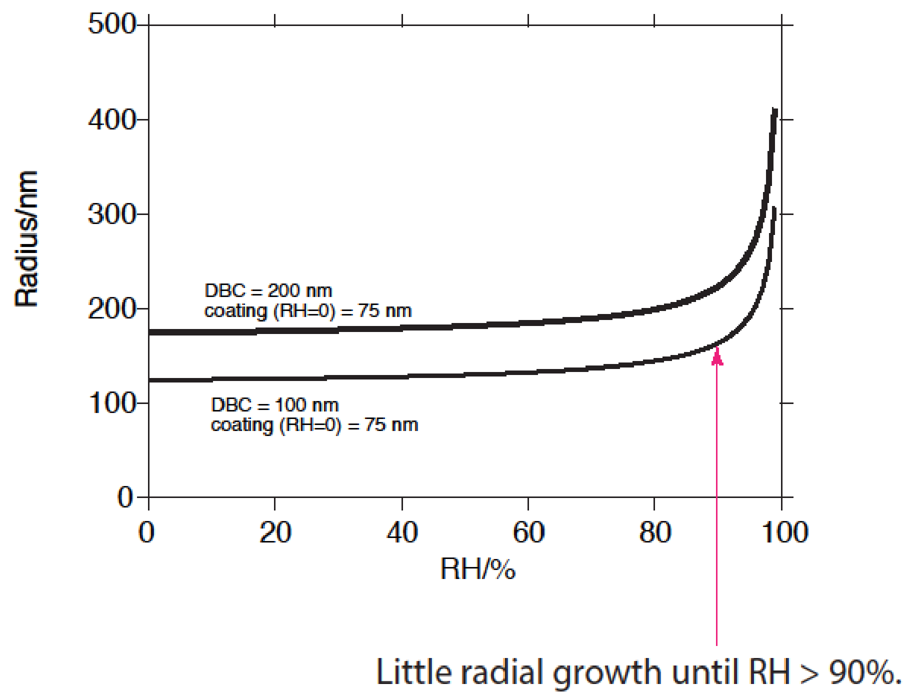

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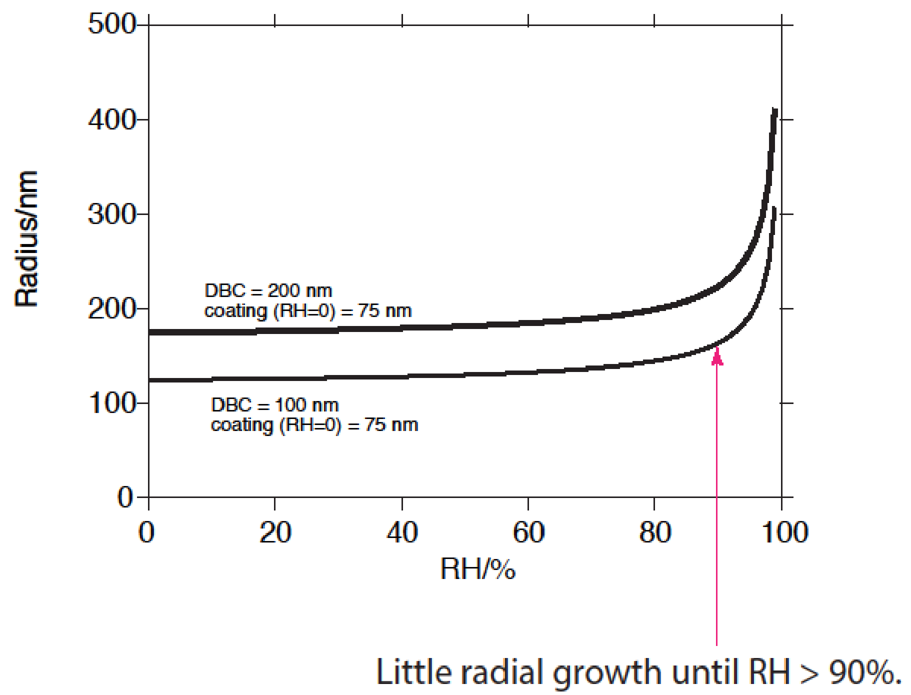

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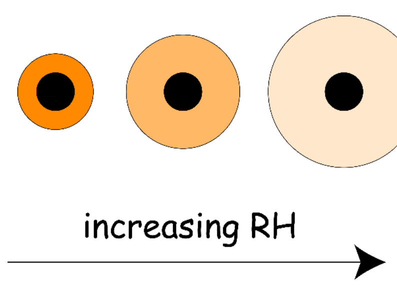
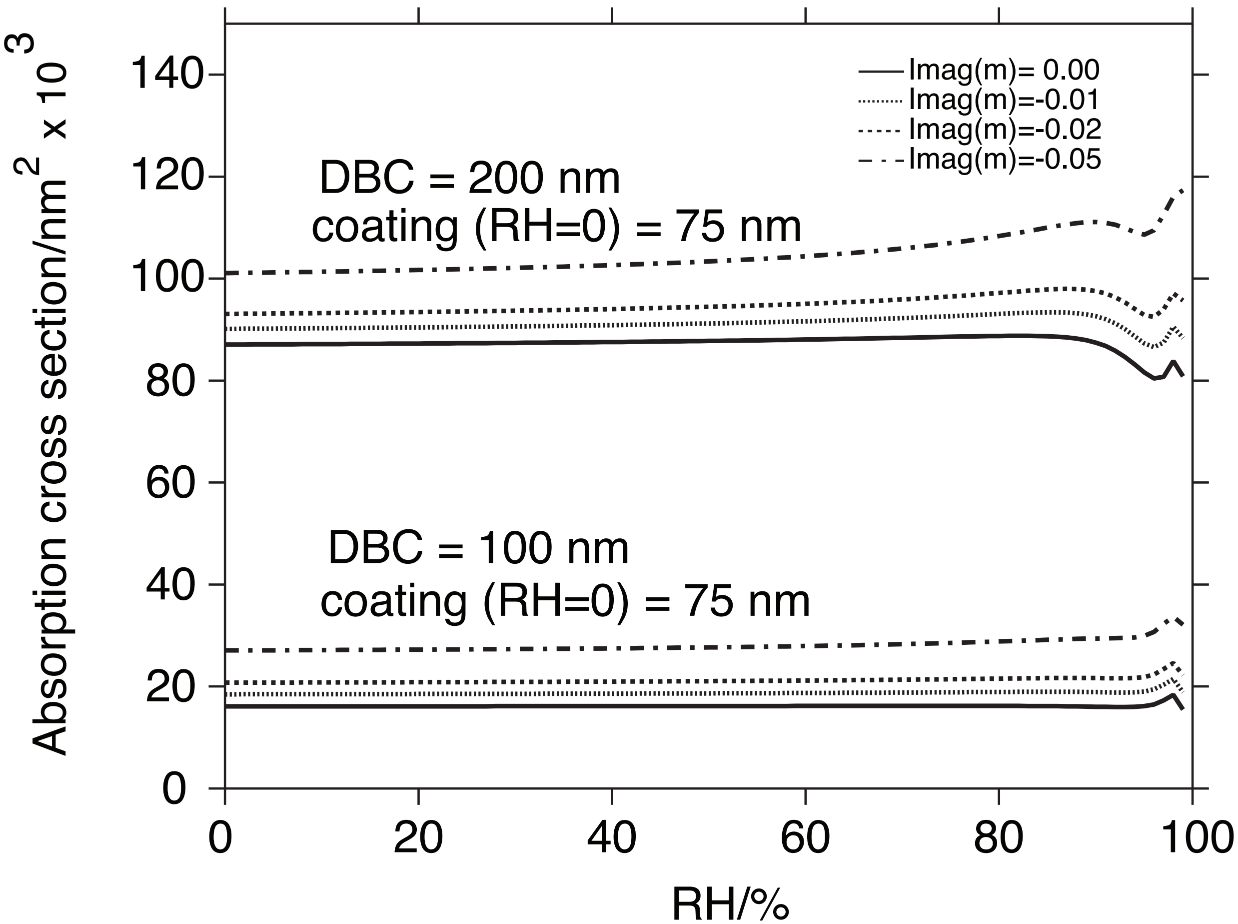


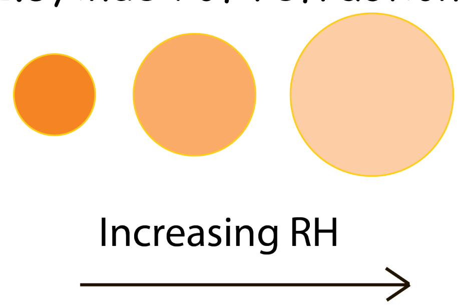
Absorption Cross Section of Coated-Core Particle



- Very little dependence on RH
- Some resonance structure at RH > 95%
- Fairly weak dependence on Imag(coating index of refraction), although some additional absorption due to coating
- Strong dependence on DBC

Absorbing Hygroscopic Sphere

Nigrosin: density ~ 1.5 g/cm^3, κ ~ 1.5, index of refraction ~ (1.6, -0.2)



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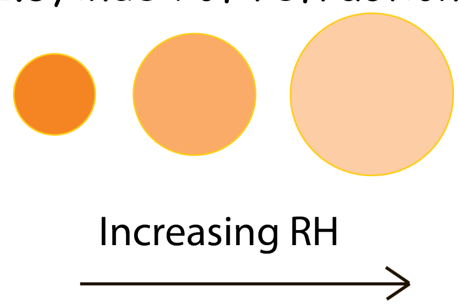

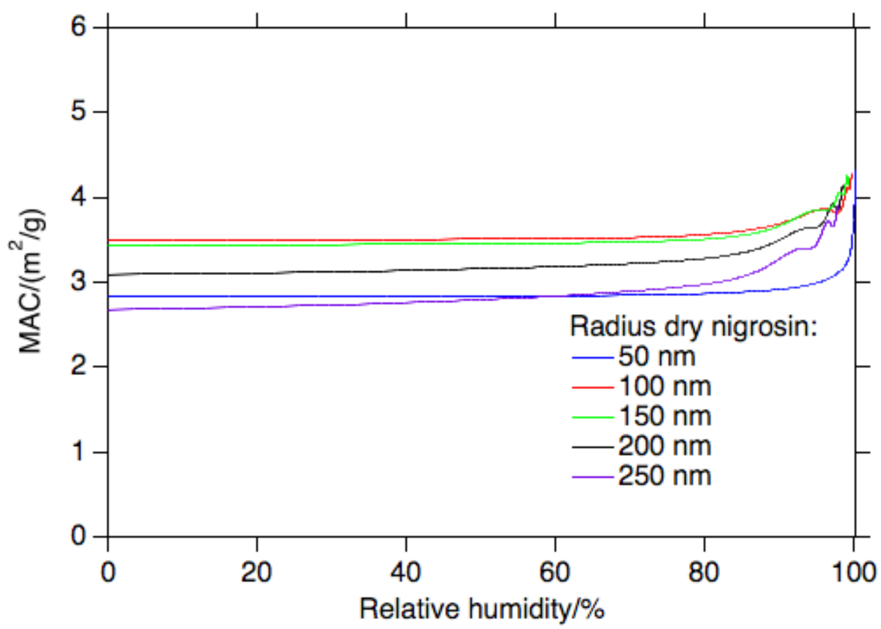

Absorption and MAC have the same behavior, as mass(nigrosin) independent of RH
Very little dependence of MAC on RH except at high RH for large particles.

Discussion

Is MAC meaningful for heavily-coated BC particles?

Do we need multiple flavors of MAC that take into account BrC, BC?

If absorption cross section is independent of RH, then measurement at one RH suffices!

Large implications for measurements/models!

Must be experimentally verified.