A Modeling Study of Electrical Characteristics of Anisotropic Conductive Film Adhesives

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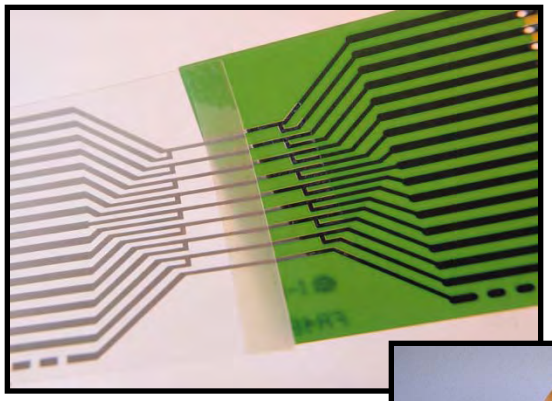
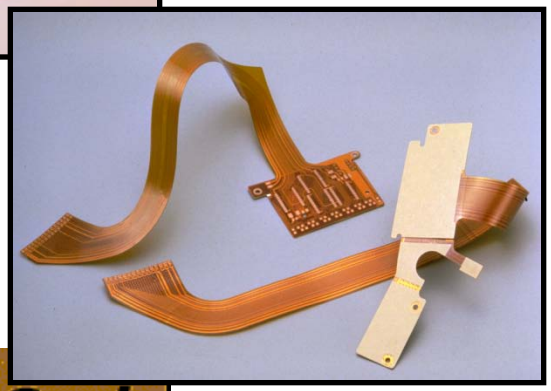
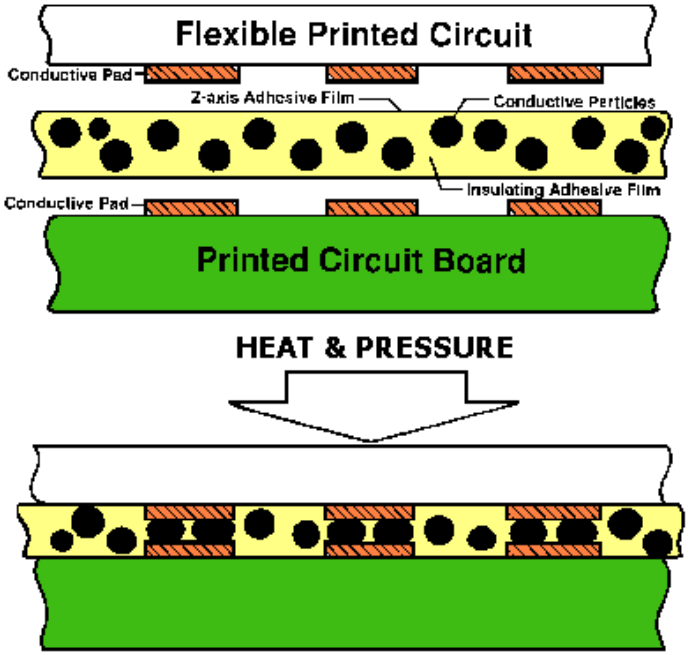
Outline

- Introduction to ACFs
- Contact resistance
- Pristine contact
- Contaminated contact
- Comparison with theory
- Conclusions

Anisotropic Conductive Film Adhesives (ACF)



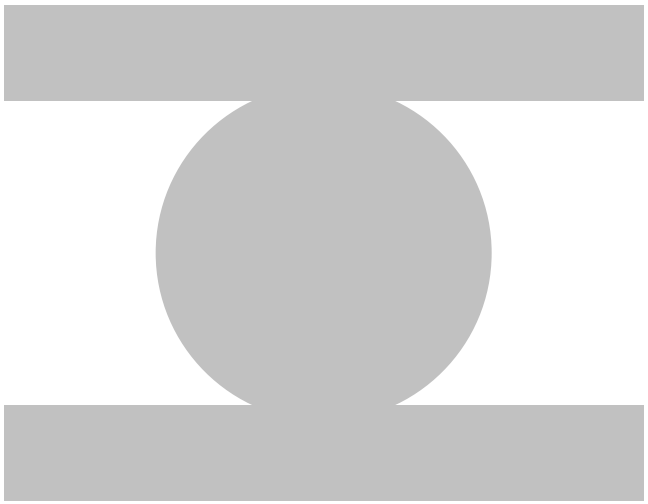




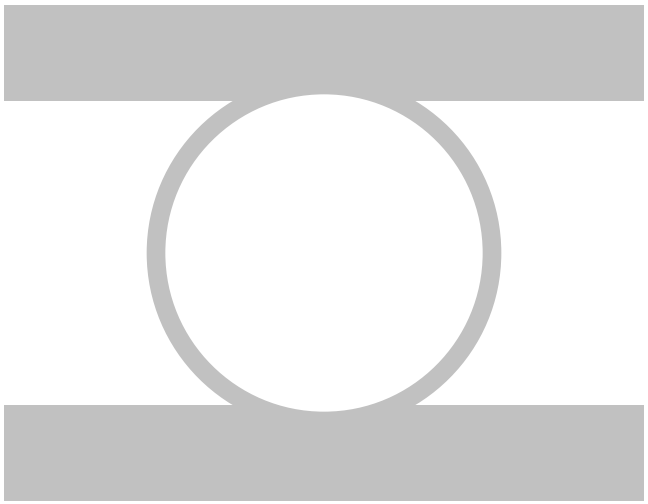
- Mechanical joining
- Electrical connection

3

Types of conductive particles



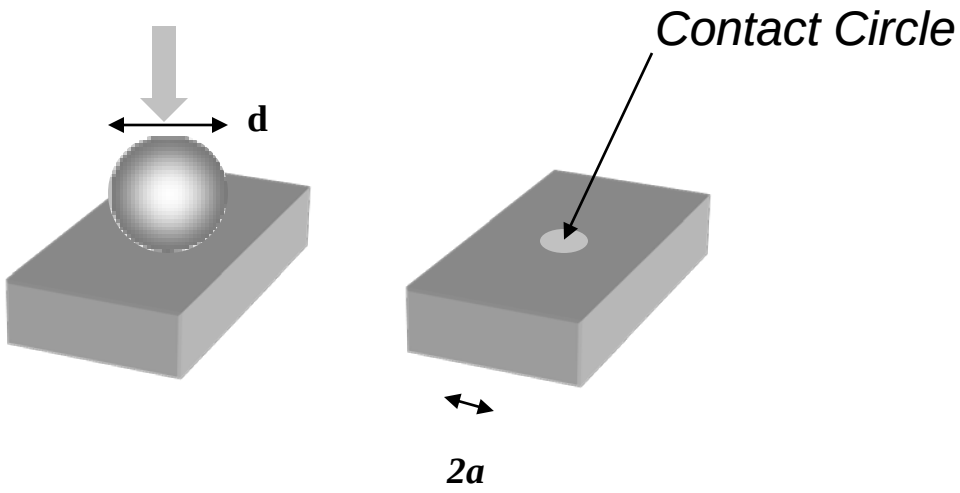
Solid metallic particle



Metal coated insulative particle

Au, Ag, Ni, etc,.

Contact resistance



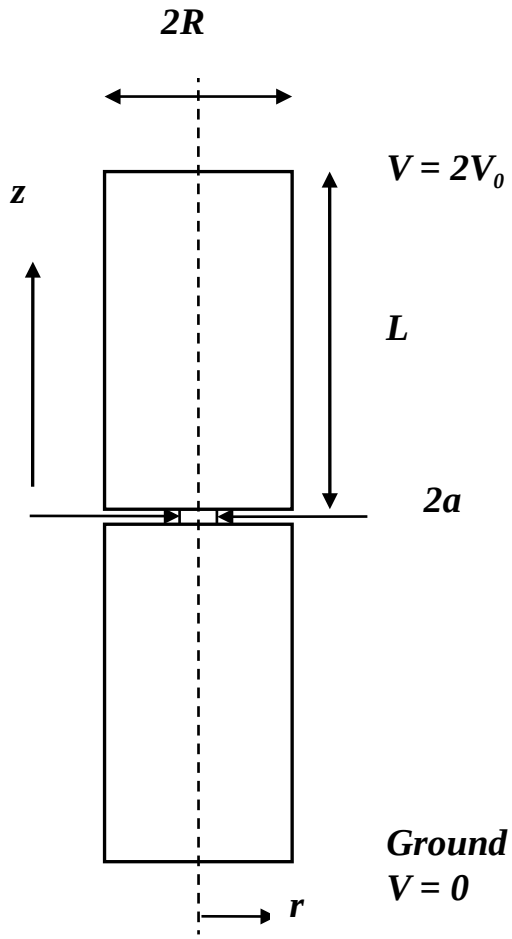
- Resistance is determined by the diameter of contact, *2a*

Contact resistance = "Constriction resistance"

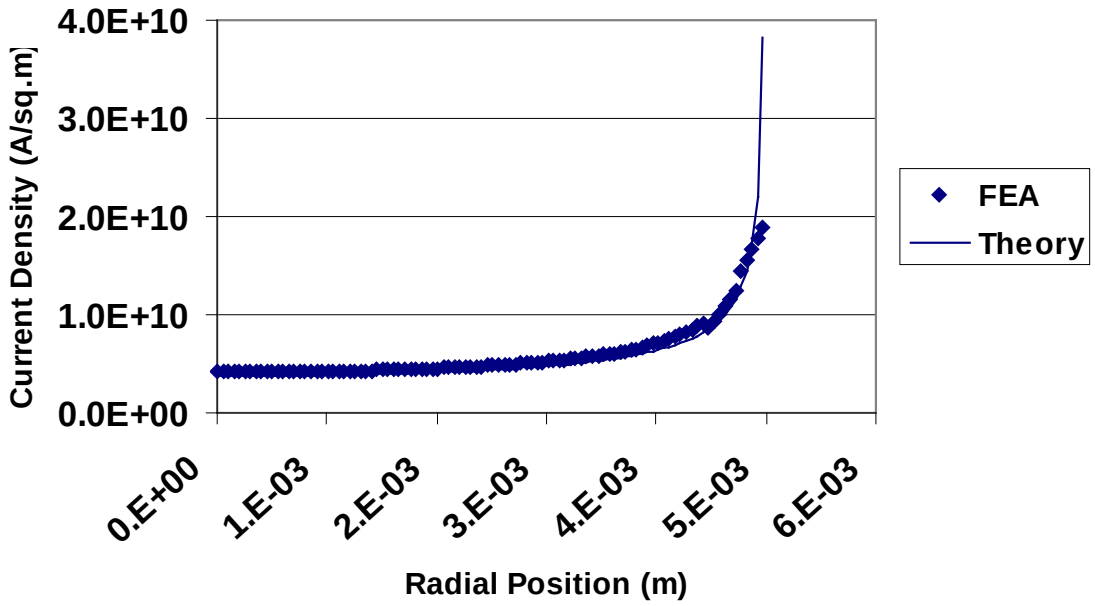
$$R_c = \rho/2a$$

- Only macroscopic
- FEA can reveal microscopic details

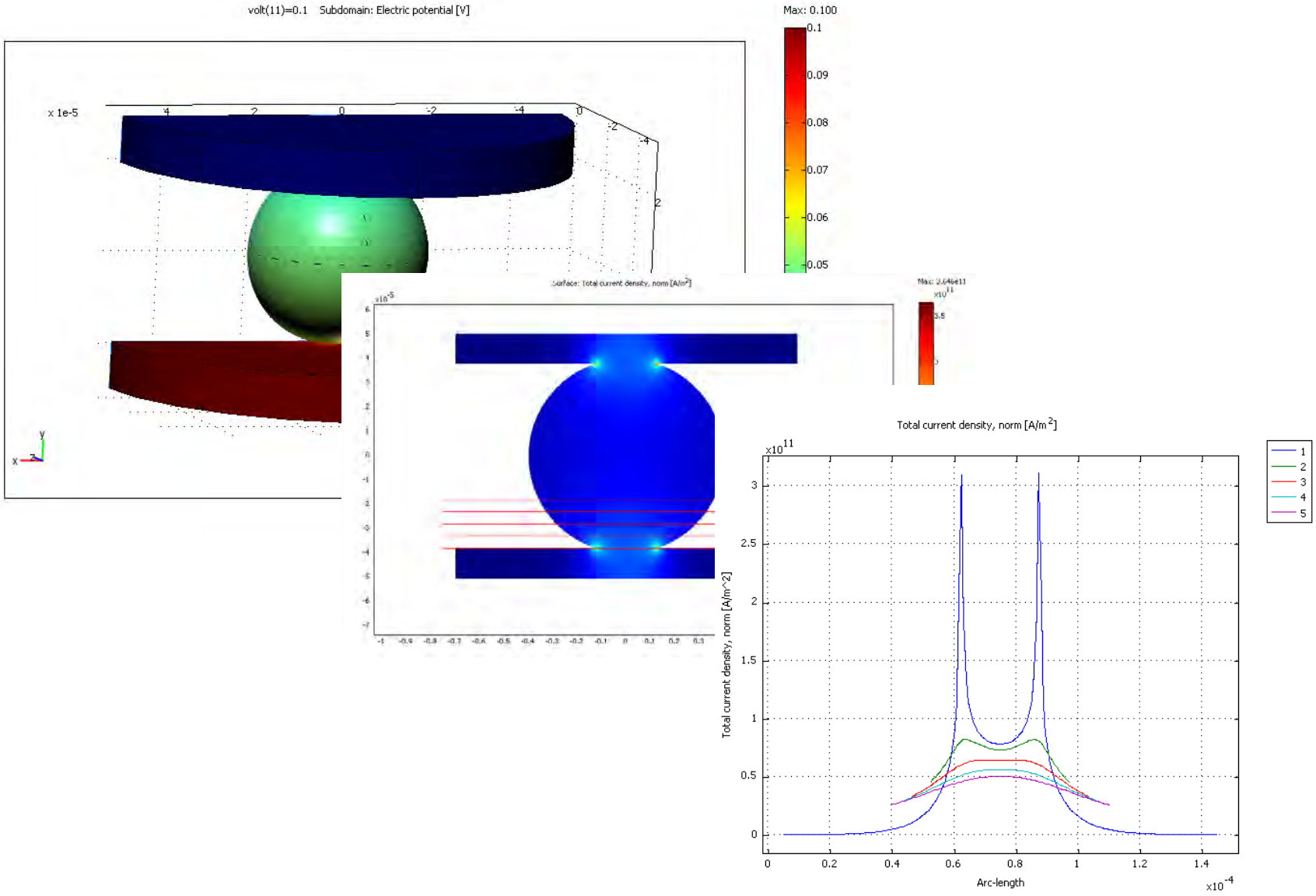
Cylindrical Constriction



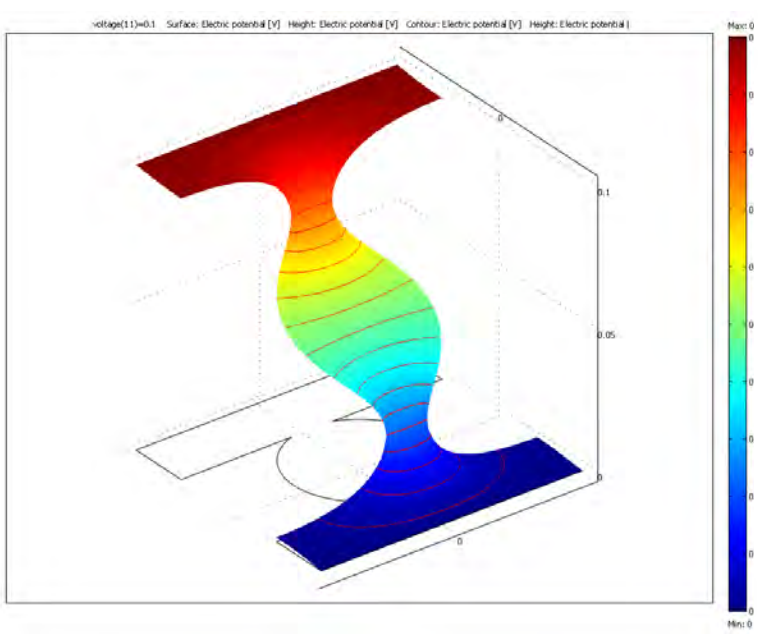
$$\nabla^2 V = 0 \quad \Rightarrow \quad J(r,0) = \frac{2V_0}{\pi\rho}\frac{1}{\sqrt{(a^2 - r^2)}}$$

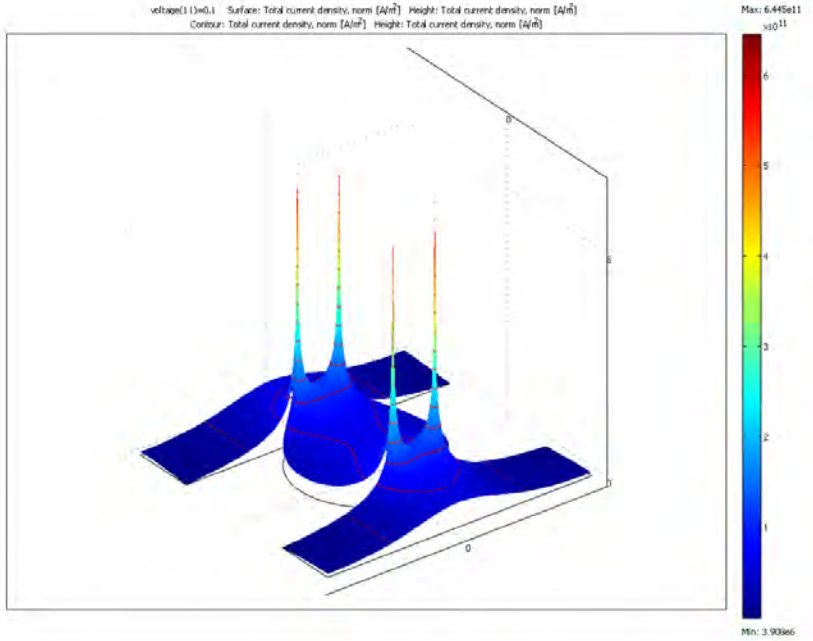


Current distribution at contact of ACF



Electrical behavior: Solid Particle

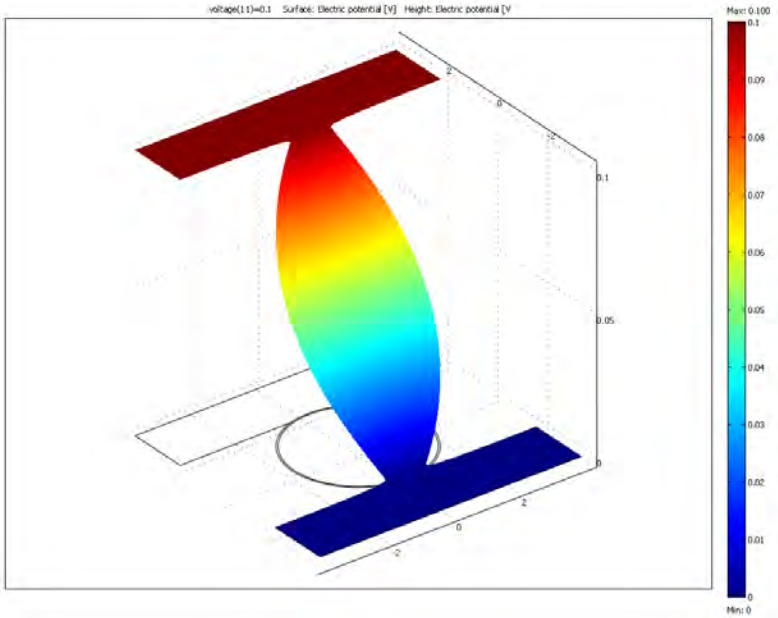




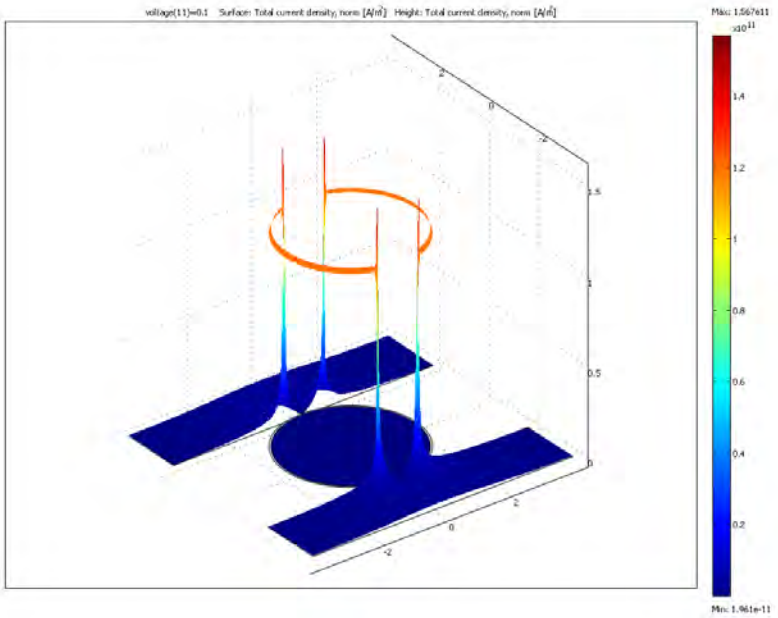
Potential difference (V)

Current density (A/m^2)

Electrical behavior: Coated Particle

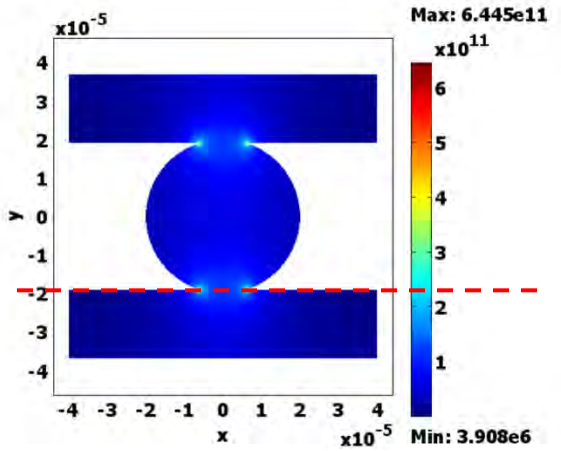


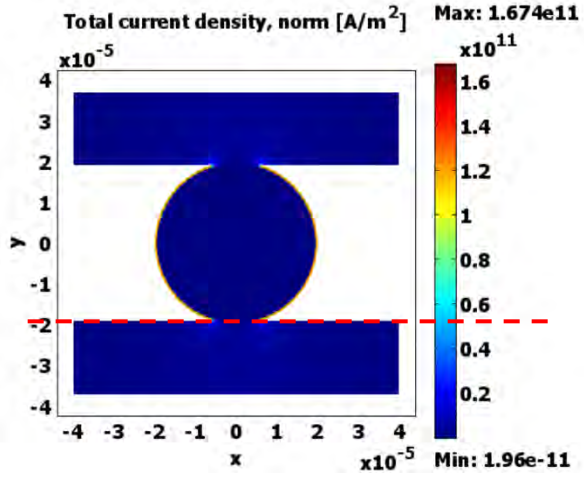
Potential difference (V)

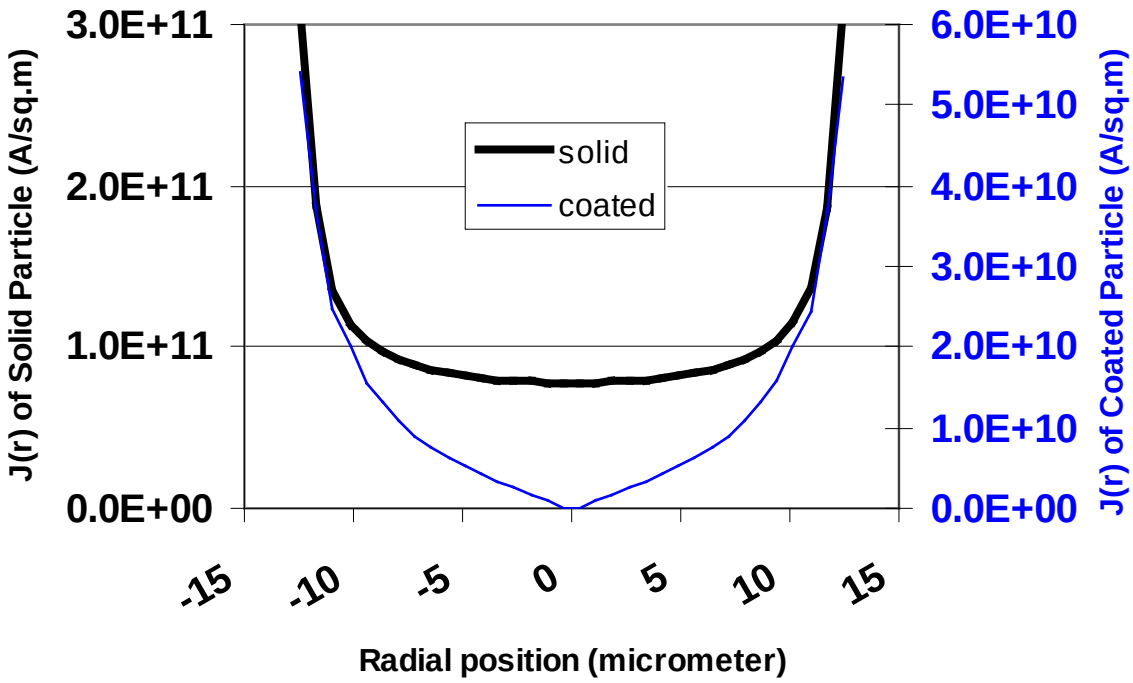


Current density (A/m^2)

Current density at contact







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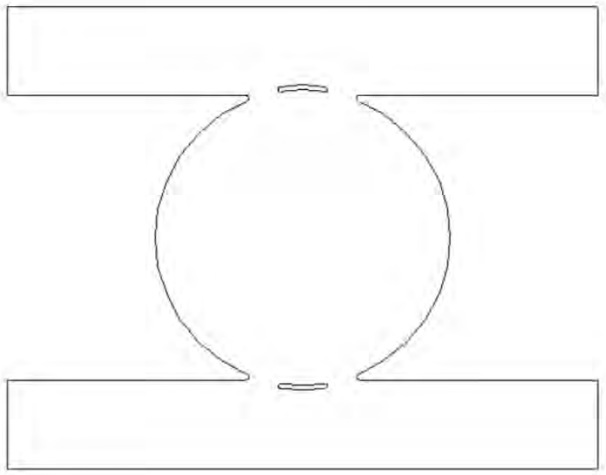
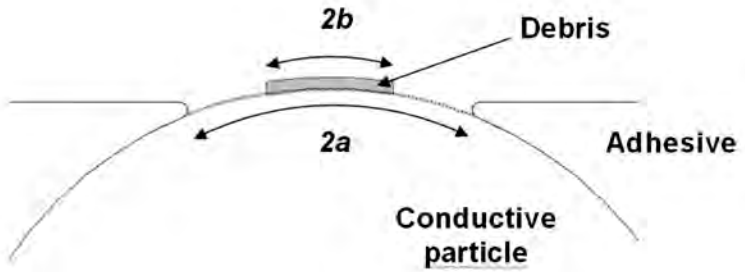
Contaminated Contact

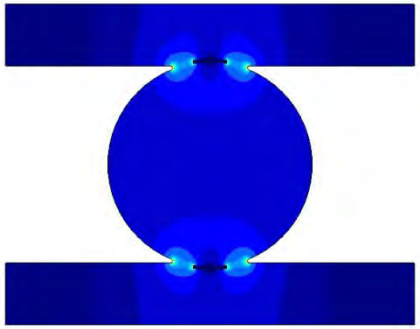




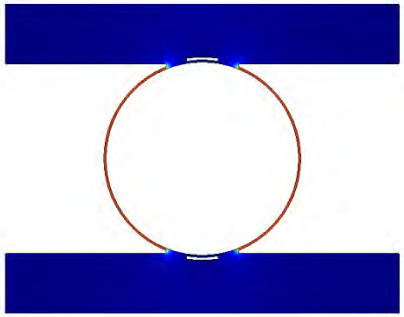
- Conductive media DC
- Vary coverage $C = (b/a)^2$ by varying b
- Parametric calculation: vary potential V to obtain current density $J(V)$
- Integrate J to get I vs. V and determine R
- R as a function of coverage C for both types of particles

Current Density

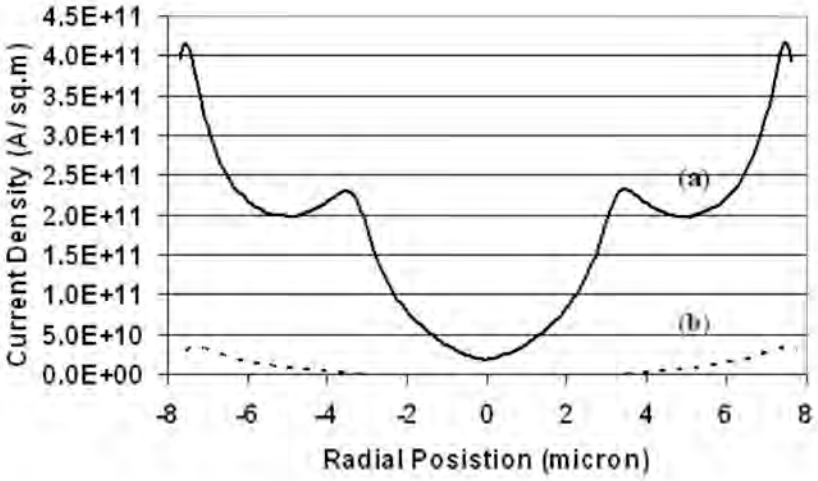
C = 0.4



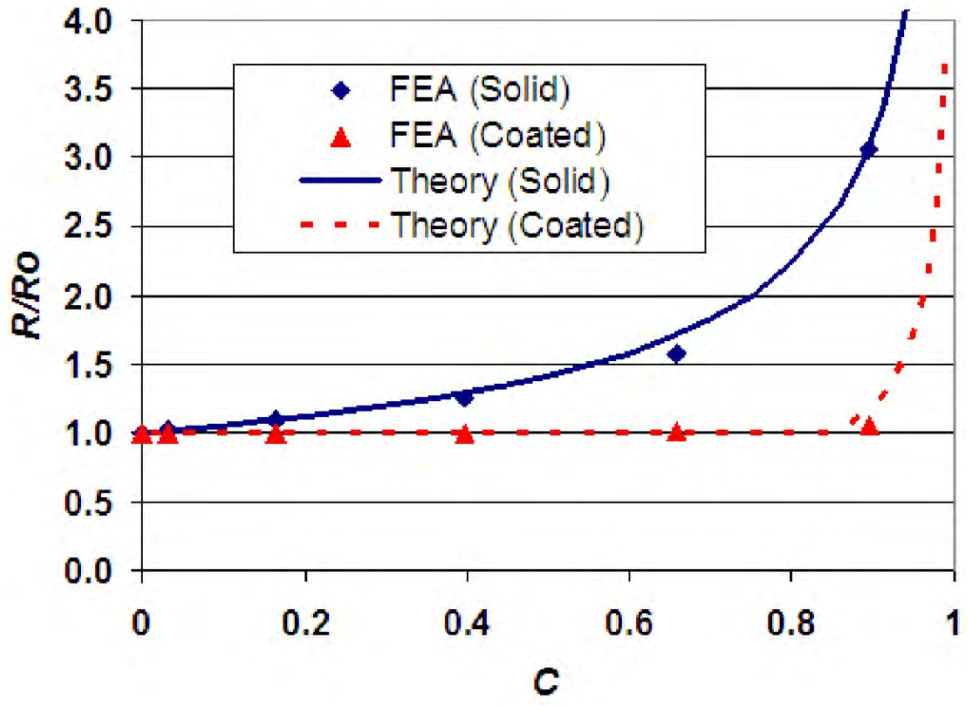
(a) SOLID METALLIC



(b) METAL COATED



COMSOL vs. Theory



SOLID METALIC

METAL COATED

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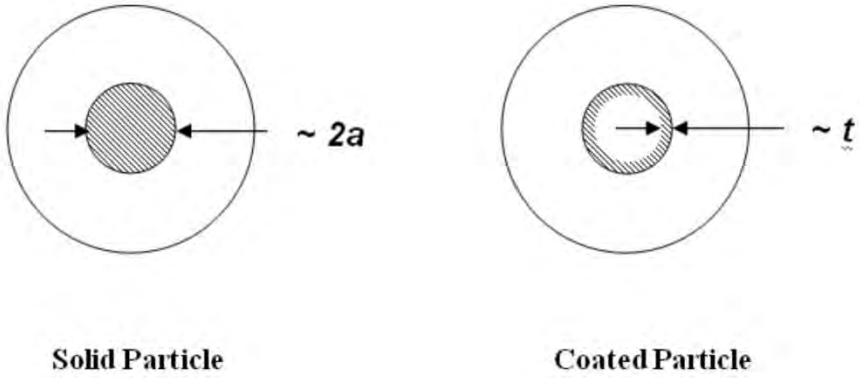
Geometrical Arguments



$$R_{SO} = \rho / a$$

$$R_{SC}/R_{SO} = 1/\sqrt{(1 - C)}$$

$$R_{SC}/R_{So} = 1 \qquad b \le (a - t)$$

$$R_{SC}/R_{SO} = k/\sqrt{(1 - C)} \qquad \textit{otherwise}$$

$$k = \sqrt{(2t/a - (t/a)^2)}$$

Conclusions

- Contact resistance can be modeled with COMSOL
- Preferential conduction at periphery of the contact circle
- The centre of contact of coated particle does not participate in current carrying
- The coated particle is electrically more immune from contamination at the bond
- Bonding with force, heat generation etc., can be modeled using multiphysics now
- Helps understand the electrical behavior of ACFs