

$$\nabla \times H = J + \frac{dD}{dt} \quad (\text{eq. 1})$$

$$J = \sigma E + J_e \quad (\text{eq. 2})$$

$$D = \epsilon E \quad (\text{eq. 3})$$

$$E = -\nabla V - \frac{\partial A}{\partial t} = -\nabla V - j\omega A \quad (\text{eq. 4})$$

$$B = \mu H \quad (\text{eq. 5})$$

$$B = \nabla \times A \quad (\text{eq. 6})$$

eq. 2 → eq. 1

$$\nabla \times H = \sigma E + J_e + \frac{dD}{dt} \quad (\text{eq. 7})$$

Time-harmonic
format

$$\nabla \times H = \sigma E + J_e + j\omega D \quad (\text{eq. 8})$$

eq. 3 → eq. 8

$$\nabla \times H = \sigma E + J_e + j\omega \epsilon E \quad (\text{eq. 9})$$

$$\nabla \times H = \sigma(-\nabla V - j\omega A) + J_e + j\omega \epsilon(-\nabla V - j\omega A)$$

eq. 4 → eq. 9

$$\sigma(\nabla V + j\omega A) + j\omega \epsilon(\nabla V + j\omega A) + \nabla \times H = J_e \quad (\text{eq. 10})$$

$$(\sigma + j\omega \epsilon)\nabla V + (\sigma j\omega - \omega^2 \epsilon)A + \nabla \times H = J_e$$

eq. 5 → eq. 10

$$(\sigma + j\omega \epsilon)\nabla V + (\sigma j\omega - \omega^2 \epsilon)A + \nabla \times (\mu^{-1}B) = J_e \quad (\text{eq. 11})$$

eq. 6 → eq. 11

$$(\sigma + j\omega \epsilon)\nabla V + (\sigma j\omega - \omega^2 \epsilon)A + \nabla \times (\mu^{-1}(\nabla \times A)) = J_e \quad (\text{eq. 11})$$

Comsol's equation