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Numerical Analysis of AC Losses in Coated Conductors with Defect for Different Arrangement

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Abstract

Many studies have been performed to investigate the AC losses of coated conductor, the AC losses of coated conductors with different defect locations both in self-field condition and external field conditions, however, have rarely been reported. This paper presents a 2D finite element model to solve the AC losses in coated conductors with defect using the H-formulation and the E-J constitutive law. The models of different arrangements coated conductors are built, whose defect is assumed to be infinitely long along the coated conductors. The influences of amplitude of external magnetic field and transport current, and defect locations for horizontal and vertical arrangement of two coated conductors on AC losses are compared and discussed. We find that the change of the defect position has a great influence on the AC loss when the transmission current or the external magnetic field is small. When the defect position is on the edge of the coated conductor, the AC loss is greater than the intact coating conductor, and when the defect position is located at the center of the coating conductor, the AC loss is smaller than the intact coating conductor. In addition, with the increase of the transmission current and the external magnetic field, the change of the defect position has little influence on the AC loss.

Numerical model and parameter

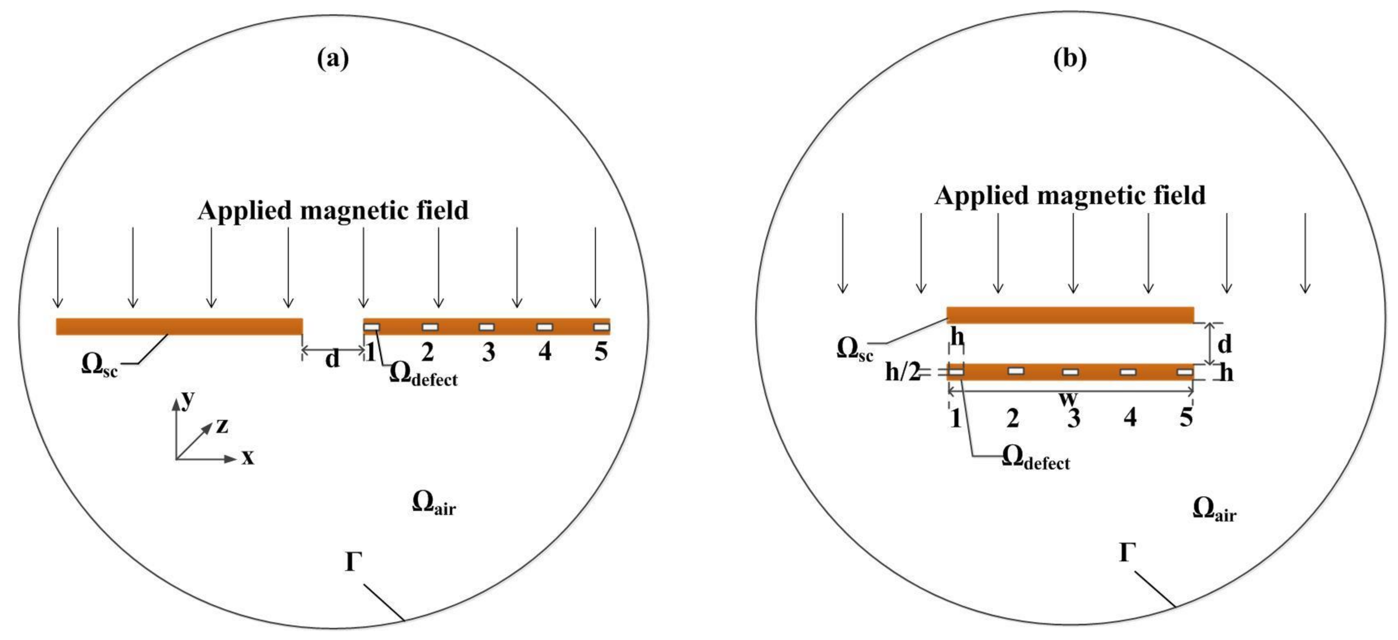

Fig. 1 (a) Horizontal arrangement model. (b) Vertical arrangement model.

TABLE I
SPECIFICATIONS OF SUPERCONDUCTING TAPE AND DEFECT

Critical current density, J_c	5e8A/m^2
n-Value, n	25
E_0	1e-4v/m
B_0	0.08T
Conductor width, w	4mm
Conductor thickness, h	50um
Defect width, h	50um
Defect thickness, h/2	25um
The gap between the two tapes, d	1mm

Result and discussion

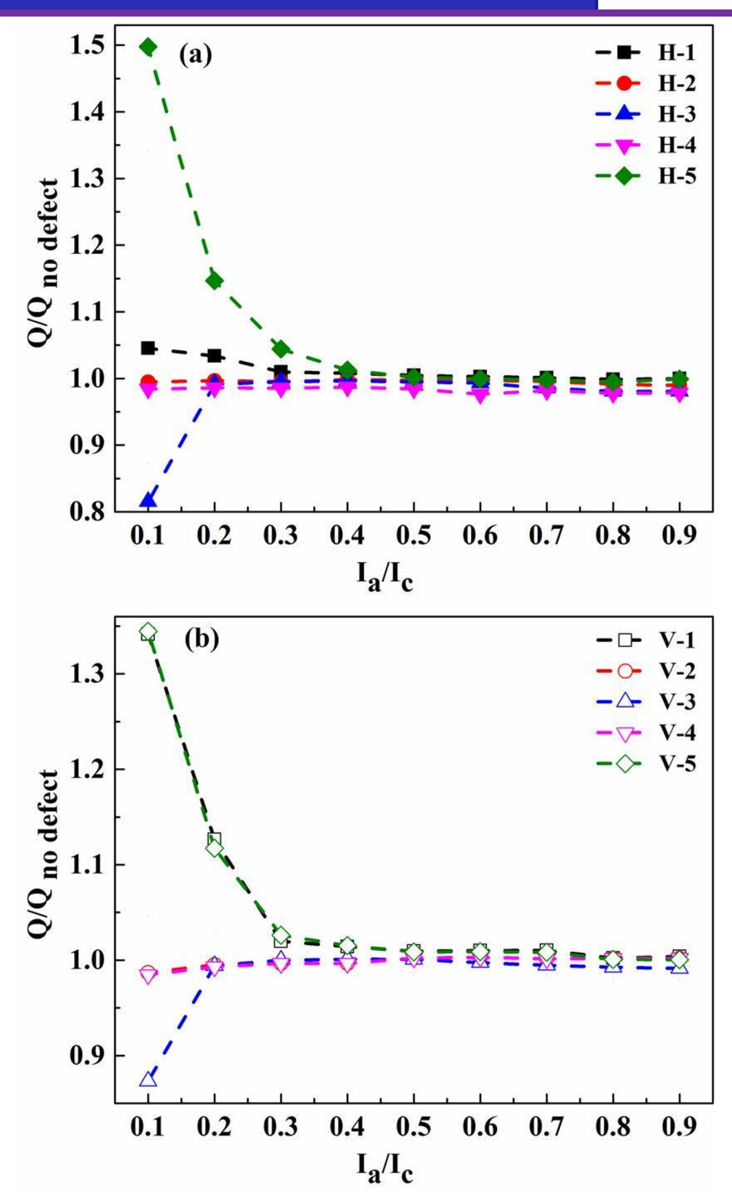

Fig. 2 (a) The normalized transmission loss of two horizontal arrangement coated conductor model at different defect location.
(b) The normalized transmission loss of two vertical arrangement coated conductor model at different defect location.

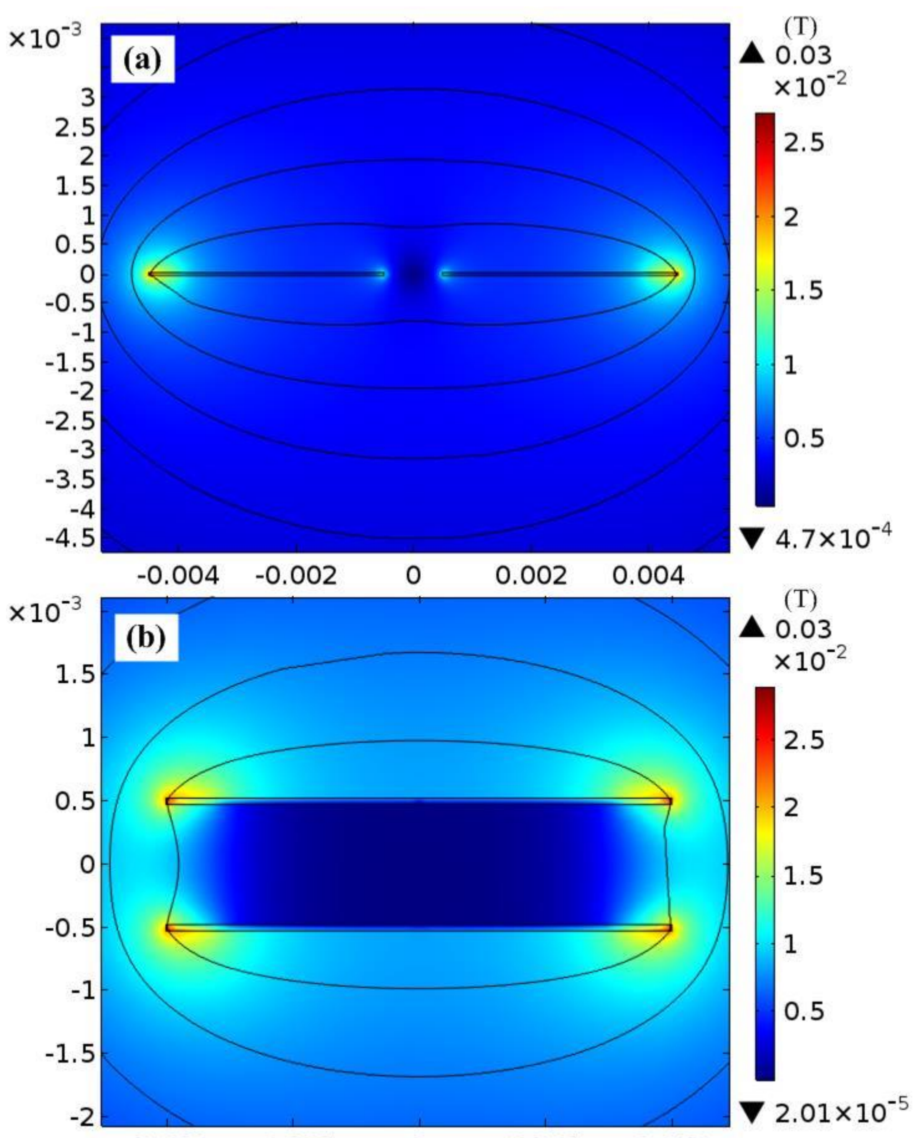

Fig. 3 (a) Magnetic flux density of two horizontal arrangement coated conductor with 0.5 Ic transport current at 50 Hz from COMSOL simulation(t=0.0038s) (b) Magnetic flux density of two vertical arrangement coated conductor with 50A transport current at 50 Hz from COMSOL simulation(t=0.0038s)

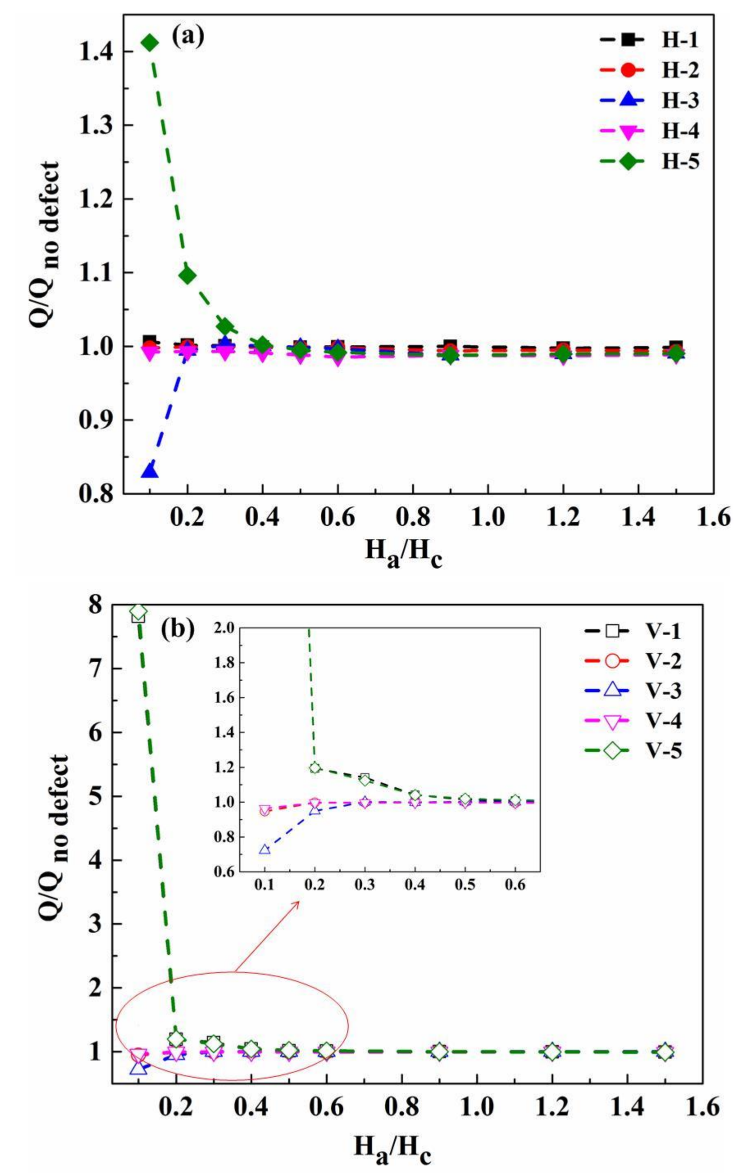

Fig. 4 (a) The normalized magnetization loss of two horizontal arrangement coated conductor model at different defect location. (b) The normalized magnetization loss of two vertical arrangement coated conductor model at different defect location.

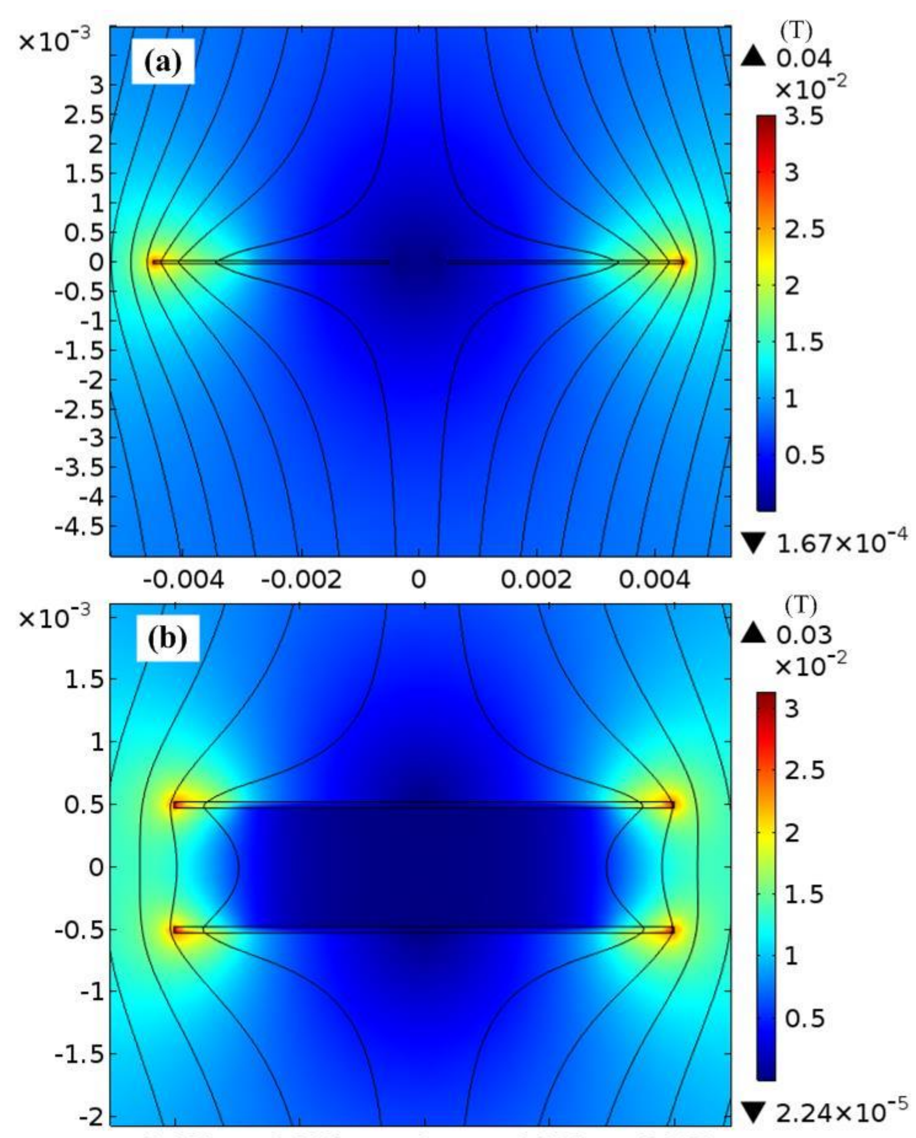

Fig. 5 (a) Magnetic flux density of two horizontal arrangement coated conductor with Hc external field at 50 Hz from COMSOL simulation(t=0.0038s) (b) Magnetic flux density of two vertical arrangement coated conductor with Hc external field at 50 Hz from COMSOL simulation(t=0.0038s)

Conclusion

At lower transport currents, for the parallel or vertically coated conductor, the defect position is at the end of the coating conductor, and the AC loss of the conductor is better than that of the perfect conductor. When the defect position is located in the middle of the conductor, the AC loss is less than that of the intact conductor. At higher transport current, the change of defect position has little influence on AC loss. At lower field, for parallel coated conductors, the loss of AC is greater when the defect position is at the outer end of the coated conductor. For vertically coated conductors, the magnetization is greater when the defects are located at both ends of the conductor, and the conductors are significantly increased. When the defect position is located in the middle of the conductor, the magnetization loss is less than that of the intact conductor. Under higher field, the position of the defect has less influence on the AC loss. Thus, the cutting edge defects should be minimized during the production process for the coating conductor .