Paris Session 2022

Nanofiller Dispersion Effect on Insulation Performances of Epoxy Nanocomposite Material: Electroluminescence, Breakdown Strength and Electrical Insulation Lifetime

D1 Materials and emerging test techniques
Preferential subject 2: Materials for Electrotechnical Purposes
Question 2.09:

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- In a part of our project, nanocomposites are being developed for the new insulating materials of stator coils of large-size rotating machines on the premise of commercialization (Figure 1).
- Loss reduction and the higher efficiency of the machines can be achieved by improving the dielectric strength, reducing the thickness of the ground-wall insulation (i.e., thermal resistance), and expanding the cross-section of coil conductors.

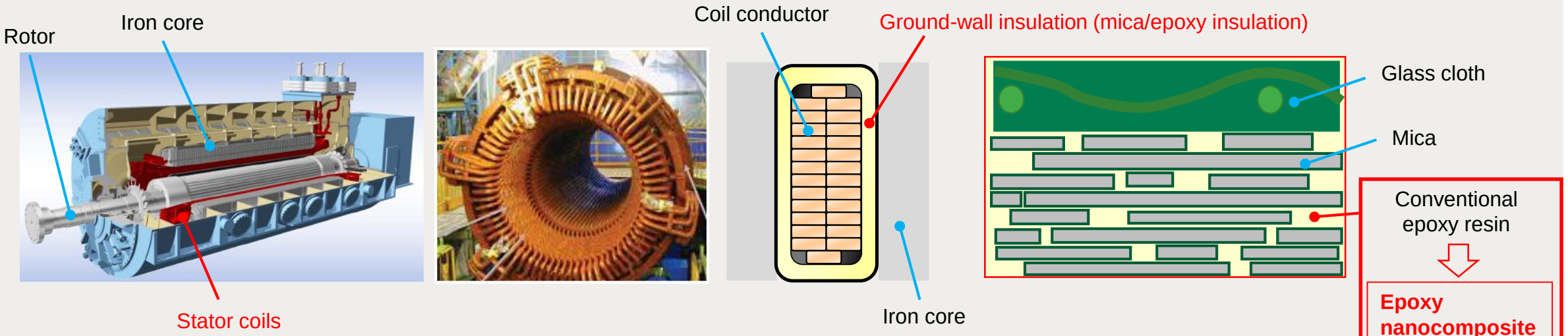
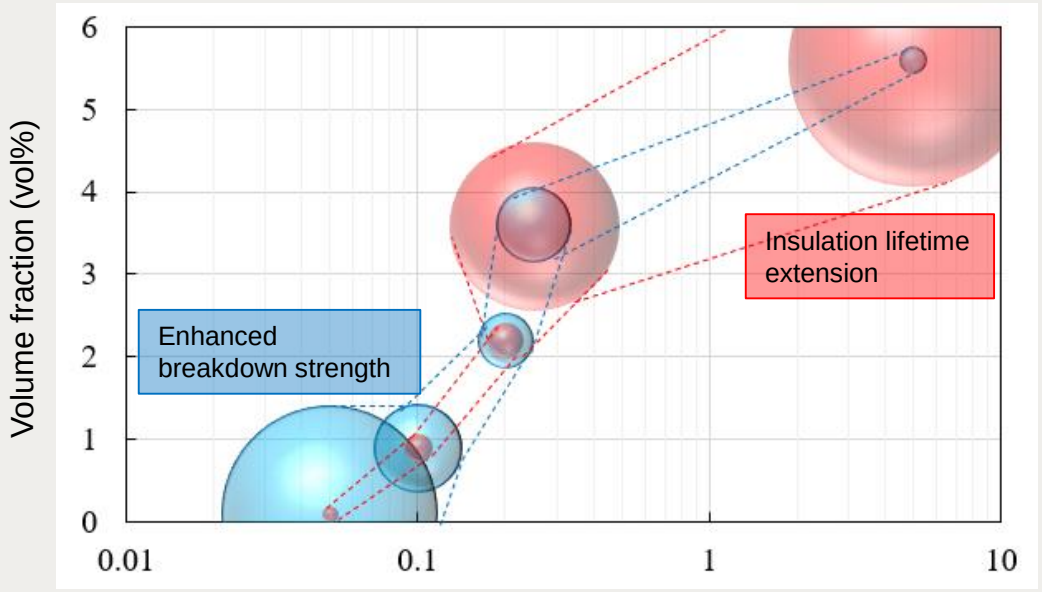


Figure 1: Insulation structure of the stator coil of the large-size rotating machine.

- Nanocomposite material design guidelines for the desired insulation performances, i.e., the appropriate nanofiller dispersion state, the type of filler material, etc., were established by a series of academic research.
- Figure 2 summarizes experimental results of the AC breakdown strength and the insulation lifetime, as functions of the maximum agglomerate size and the volume fraction of TiO_2 nanoparticles. (Larger circle represents the superior insulating properties.)



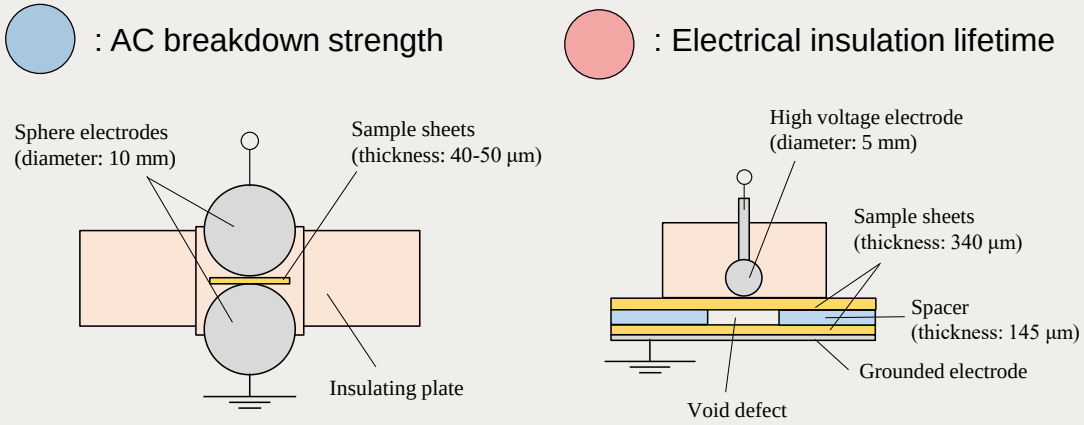


Figure 2: Breakdown strength enhancement and lifetime extension effect as functions of the maximum agglomerate size and volume fractions.

- Real-scale stator coil models were manufactured, in which conductors were wound by mica tape and vacuum impregnated with nanoparticle-filled epoxy resins (Figure 3). The insulation lifetime characteristics, the most essential factor for the stator coils, were successfully demonstrated (Figure 4).
- At present, other properties, such as thermal and mechanical degradations, are being investigated. The nanocomposite material is technically feasible for practical use, if these are cleared.

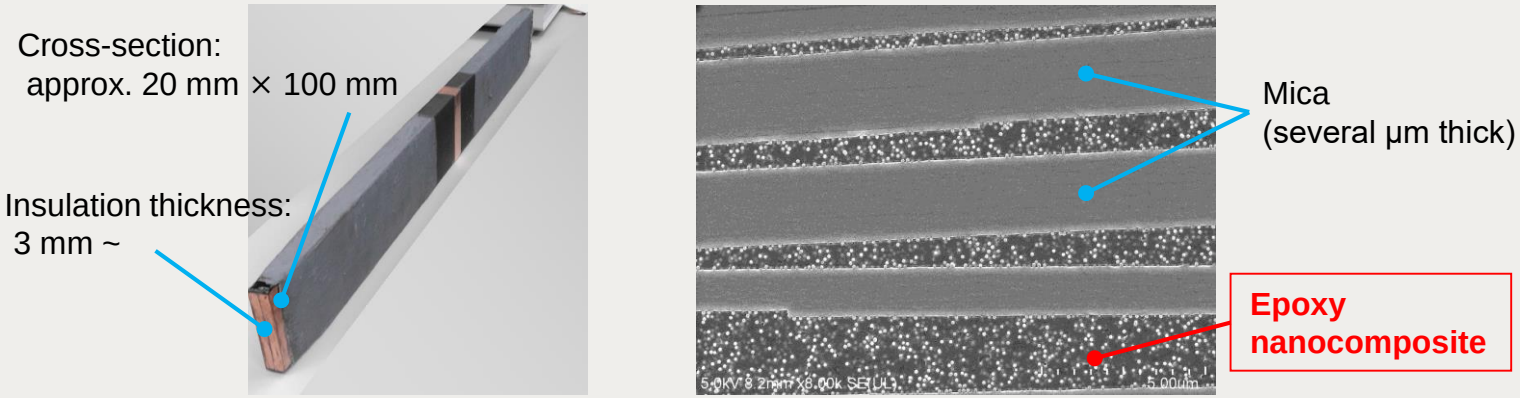


Figure 3: Real-scale stator coil model and its SEM image.

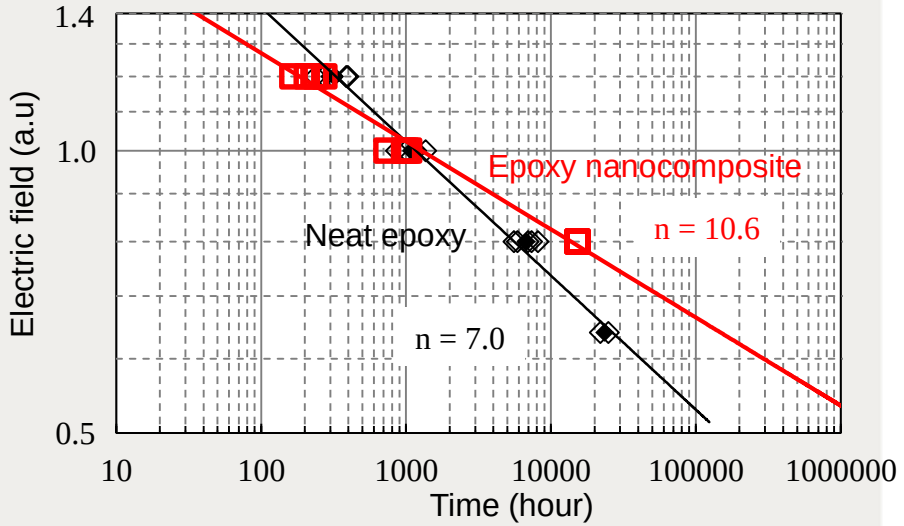


Figure 4: Voltage-endurance test.