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Editorial: Advanced technologies for electrical engineering

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Editorial on the Research Topic
Advanced technologies for electrical engineering

Energy crisis and environmental pollution are two major themes currently faced by human society. The construction of a strong smart grid with super/ultra-high voltage network as the backbone and clean energy transmission as the leading shows a more important strategic role than ever since. However, the rapid development of clean and renewable energy technologies represented by wind and solar energy and the continuous growth of load demand put forward higher requirements for the safe operation of power systems, the guarantee of power supply quality, and conversion and utilization efficiency of electric energy. The performance of electrical equipment based on traditional electrical materials is often limited by their electromagnetic parameters, which can not meet the needs of the power system anymore under the new situation.

Based on the above purpose, this special issue was established. To our relief, five papers were accepted in 9 months. These five papers not only put forward new research ideas on traditional problems, but also introduce new materials and new technologies.

Polytrifluorovinyl chloride (PCTFE) is one of the earliest fluorinated plastics synthesized and commercialized. It has very low dielectric constant and loss, coupled with good resistance to water vapor penetration, corrosion, light transmission, creep resistance and other excellent properties. Aiming to provide guidance for the future research and application of PCTFE-based materials, Zou et al. reviewed the history of the development and the research progress of PCTFE, and finally proposed the perspective (Zou et al.). There has been increasing interest in applying PCTFE-based materials to energy applications such as piezoelectric and electrostrictive devices, fuel cell membranes, and photovoltaic power generation. It can be expected that these areas will be further explored and will greatly attract the interest of industrial and academic researchers.

XLPE power cables are widely used around the world for their excellent transmission stability and economy, as well as being laid underground without occupying space resources. However, the insulation conditions for evaluating XLPE cable results using PDC techniques are often inaccurate because the parameters of the current Debye model are determined in the uniform aging assumption, not in the true non-uniform case. To solve this problem, Zhang et al. proposed the modified Debye model considering the real non-uniform situation, and proved that the effectiveness of the modified model by the comparison of the PDC test results with non-uniform and uniform aging materials (Zhang et al.). The parameters of extended Debye model often overestimate the insulation performance of cables, while the characteristic parameters obtained by modified Debye model better reflect the real situation of non-uniform aging of cables. The results show that the method has high accuracy in the evaluation of cable insulation state.

Composite insulators are widely used in external insulation of transmission lines because of their excellent anti-pollution flashover properties. However, in decommissioned composite insulators, a large amount of silicone rubber material is difficult to degrade naturally, resulting in great pressure on the environment. Thus, Yang et al. proposed a method for recycling waste silicone rubber by microbial degradation (Yang et al.). Composite insulators that have been decommissioned naturally during 10–15 years of operation are collected. The decomposition products of silicone rubber were obtained by using the dominant species, and the chemical reaction process was deduced according to the three-dimensional structure characteristics of the monomer. The biodegradation process does not require the participation of strong acid and strong base, and the recovery method is safe and effective. At the same time, nano-silica was separated from waste silicone rubber and modified with surfactant. The particle size of nano-silica is reduced to ~18nm, which has excellent dispersion and high economic value.

The electric field distribution along the gas-solid interface determines the reliability of the insulating element. However, dielectric gradient insulating elements prepared by conventional methods are thought to control only the internal electric field, but are not conducive to surface insulation, especially when the electrode is at an acute Angle to the dielectric surface. Therefore, Shen et al. sought to elucidate that meta-surface based on dielectric tensor rotation constructed by the electric field induced assembly (EIA) method could improve surface insulation (Shen et al.). The self-assembly and orientation axis rotation of packing particles near the interface were observed by *in situ* optical observation, which revealed the relationship between dielectric tensor rotation and electric field refraction. The surface of the meta-structure induced by EIA on a basin insulator is simulated. Meta-structured surfaces have negative and high decreasing permittivity, limiting electric field paths and transferring electrical stress from the gas to the insulator, which provides theoretical support for optimizing the surface electric field.

Polytrifluorovinyl chloride (PCTFE) is one of the first fluoropolymers developed and commercialized and has been used in high frequency communications, corrosion protection and medical packaging. However, the relatively poor processing and mechanical properties due to the regularity and crystallinity of polymers limit their wider application. Here, Yang et al. attempted to physically modify the original PCTFE by mixing it with the pyrolysis product (FCO) (Yang et al.). The results showed that the addition of FCO accelerated the molecular relaxation of PCTFE, delayed the crystallization process of PCTFE, and significantly improved the processing and mechanical properties of PCTF. When the FCO load is 10%, the balance torque is reduced by 20%. Compared with PCTFE, the elongation at break and impact strength are increased by 3. 6 and 10.6 times, respectively.

Electric energy has become an indispensable source of energy in our life. With the continuous progress of science and technology, materials research in the field of electrical engineering is also progressing and will continue to improve our lives. Because of the excellent electrical property of 1D/2D nanomaterials, high permittivity is easily obtained near the percolation threshold in nanomaterial/polymer composites. However, the formation of conductive channels also increases leakage current, which causes high dielectric loss and low breakdown strength. The development of new preparation techniques to regulate the spatial arrangement of 1D/2D fillers is a potential solution. Moreover, functionally graded materials are another solution. For the recycling of electrical materials, biological methods are also an effective means of degradation.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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