ADDITIVE MANUFACTURED FIELD CONTROL RING FOR IMPROVING EXTERNAL DIELECTRIC OF VACUUM INTERRUPTER

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ABSTRACT

Worldwide, more than 90 % of the switchgear produced for medium voltage application is based on vacuum switching technology [1]. In vacuum interrupters (VI) vacuum is used as the switching medium and internal insulation, while the external insulation is usually provided by silicone, epoxy resin or sulphur hexafluoride (SF_6). As SF_6 is the greenhouse gas with the highest global warming potential GWP 100 year of 23,500 [2], the EU is progressively prohibiting its use [3]. External electric strength of VI is therefore an important issue.
To improve the electric strength of an insulation system, triple points are usually considered, as the emission of electrons is particularly probable here. To reduce the electric field strength in the triple points of the VI field control rings are used. For this study, the field control rings were additively manufactured from polylactide (PLA) and the surface was electroplated. Additive manufacturing makes it possible to produce prototypes quickly and cost-efficiently. Electroplating then transforms the insulator into a conductive field control element.
As insulation systems are designed with the highest voltage that occurs in the grid, the measurements are carried out with lightning impulse voltage. The extended up-and-down method according to Powell and Ryan is used as test procedure to determine statistical withstand voltage [4]. As a result of the investigations, it can be summarized that additive manufactured and electroplated field control elements function in the same way as conventionally manufactured metallic field control elements. After several breakdowns, small traces of melting can be observed on the rings, but the functionality is still given.

References

[1] Falkingham, L. T.: The Strengths and Weaknesses of Vacuum Circuit Breaker Technology, 1st International Conference on Electric Power Equipment - Switching Technology, Xi'an, China, 2011.
[2] IPCC: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. (Cambridge University Press, 2013)
[3] REGULATION (EU) 2024/573 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 February 2024 on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014, Official Journal of the European Union 2024/573, 2024.
[4] Hauschild, W. Mosch, W.: Statistical techniques for high-voltage engineering, Peregrinus, Stevenage, 1992.

Primary Topic: Vacuum Interrupters and Spark Gaps