Remote LIBS for assessing the condition of field-aged composite HV outdoor insulators

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The use of composite insulators in overhead transmission lines and in substations has been rapidly increasing in the last two decades, mainly due to their excellent performance even under pollution conditions, where the conventional ceramic insulators commonly fail [1]. However, their insulation performance can be deteriorated in service conditions as a result of ageing, caused by the interactive effects of the environmental, electrical and mechanical stresses. Therefore, condition assessment of the insulators in service is necessary in order to ensure high reliability of power systems. Several diagnostic techniques have been proposed [2] for this purpose, but the problem is that their implementation assumes disconnection of the insulators from the lines, sampling of the polymeric housing and measurement in the laboratory. This means that the insulators are destroyed and cannot be reinstalled in the lines, resulting in high financial costs. Hence, the development of non-destructive diagnostic techniques for real-time, on-site inspection of the insulators condition is required.
To this end, Laser-Induced Breakdown Spectroscopy (LIBS) was found to be an efficient and reliable technique for assessing the state of polymer-based HV outdoor insulators in service. In this work, a number of insulators are examined, which had been installed in the electrical transmission network of Crete for a time period of ten years or longer. Diagnosis of the insulators state is achieved by calculation of specific spectral indicators, which reflect the extent of chemical modifications induced to the insulators surface as a result of their longtime presence in the field. Standard and remote LIBS measurements have been performed successfully both in the laboratory and on-site, respectively. A remote LIBS proof-of-principle diagnostic model is presented, which is based on measurements via off-axis Newtonian collection optics, thus indicating that LIBS can indeed become a field deployable technique for the efficient and reliable assessment of the condition of HV outdoor insulators in service.

References

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