Electromagnetic Analysis of an Optical Measuring Device Installed in a Transmission Line

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Abstract

Optical devices can be successfully used in many electromagnetic measurements. Particularly, these equipment can be installed in high voltage transmission lines (up to 240 kV) where the magnitude of the electric current can reach values of, approximately, 2500 A. Therefore, there is an intense magnetic field around the measuring device that must be carefully characterized for the design and optimization of its components, in order to provide high sensitivity and accuracy. Therefore, numerical simulations can be used as a powerful tool to understand the complex physics involved and save time and cost. In this study, COMSOL Multiphysics® software was applied to the investigation of the electromagnetic behavior of an optical crystal submitted to the magnetic field generated by electric current in a near positioned metallic conductor.

Moreover, the influence of a ferromagnetic apparatus (magnetic concentrator) on the magnetic field acting upon the crystal was investigated. The AC/DC Module and the Magnetic and Electric Fields physics interface were used to perform the analysis in a three-dimensional geometry. Three cases were evaluated: i) a system composed by the metallic conductor and the optical crystal only; ii) a system constituted by the metallic conductor, the optical crystal and the magnetic concentrator; and iii) a system composed by an arrange of three set of metallic conductor, optical crystal and magnetic concentrator separated by an arbitrary distance. In particular, the current applied to the metallic conductor was varied as well as the relative distance of the optical crystal regarding the metallic conductor and the magnetic concentrator. In case iii, the interaction of the magnetic field generated by the three set of conductor-crystal-concentrator arrange, displaced by an angle of 120°. The analysis showed that the magnetic concentrator had a significant impact on the magnetic field acting on the optical crystal and that there was a significant interaction among the magnetic fields generated by the three set of conductor-crystal-concentrator arrange.

Reference

1. Juan C. Olivares-Galván et al., Calculation of the Magnetic Field Intensity in a Rectangular Conductor Carrying Current in Electromagnetism Introductory Courses, Proceedings of the COMSOL Conference, Boston, MA, USA (2009).

Figures used in the abstract

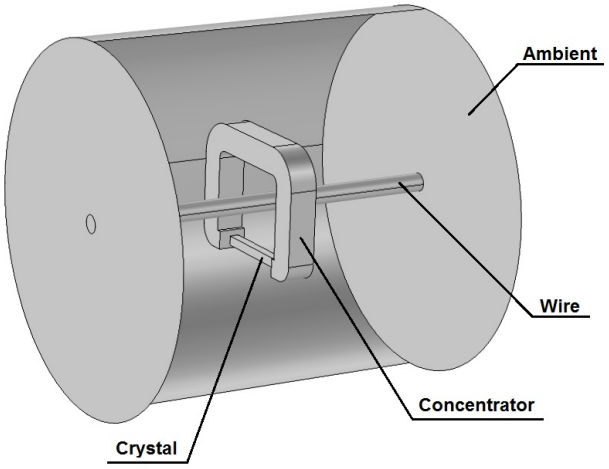

Figure 1: System arrangement.

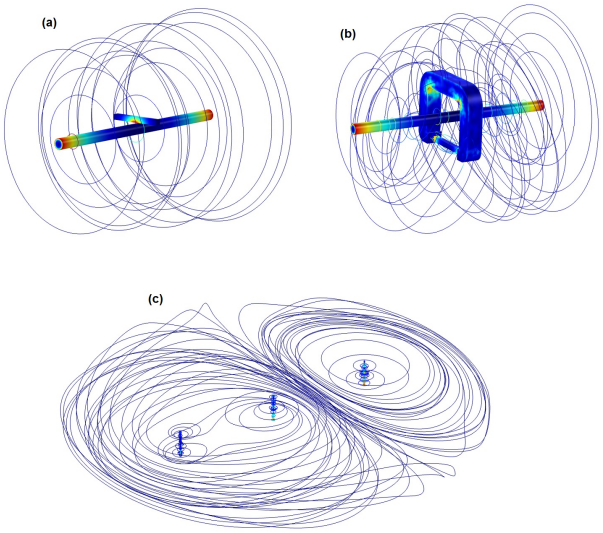

Figure 2: Plot of current density norm on the metallic conductor, the magnetic flux density norm on the optical crystal and the magnetic concentrator and streamlines representing the magnetic field for (a) case 1, (b) case 2 and (c) case 3.