**Single is better than double: Analysis of thermal poling configurations using 2D numerical modeling**

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**Abstract:**

Thermal poling, a technique to create permanently effective second-order susceptibility in silica optical fibers, has a wide range of applications, such as frequency conversion, electro-optic modulation, switching and polarization-entangled photon pairs generation. After many works where a conventional configuration anode-cathode was used, in 2009 a new electrode configuration (double-anode) was adopted, which allows for a more temperature-stable depletion region formation and a higher value of effective Chi2 [1, 2]. In this work we demonstrate, via numerical simulations realized in COMSOL® multiphysics, that in a double-anode configuration the effective value of Chi2 strongly depends on the relative position of the core with respect to the electrodes, requiring an accurate and precisely tailored geometry of the fiber, while in a single-anode configuration this value, for standard poling conditions [1] is almost independent of the position of the core, offering the possibility of relaxing the manufacturing constraint of the fiber fabrication. We also demonstrate that, in the same experimental conditions, the maximum value of effective Chi2 induced by thermal poling in double-anode configuration is smaller than the one obtained in single-anode configuration for any position of the core in the range between the anodic surface and the geometric center of the fiber.

Finally, we report the experimental observation of depletion region formation in a twin-hole fused silica fiber poled in single-anode configuration. Using a QPM SHG experimental set-up, we demonstrate that the value of Chi2 obtained in the single anode configuration is at least as large as for the double anode one.

[1] W. Margulis, O. Tarasenko, and N. Myren, Opt. Express **17**, 15534 (2009).

[2] H. An, and S. Fleming, Opt. Express **20**, 7436 (2012).

**Summary:**

Thermally poled silica fibers can be used to realize functions such parametric frequency conversion with a number of advantages over bulk free-space components. We theoretically demonstrate that a simplified electrode configuration (single-anode) in thermal poling experiments of step-index fused silica fibers, allows for reducing the need for a precisely positioned core with respect to the anode and furthermore that the final Chi2 value obtained is even higher than the highest possible obtainable in double-anode configuration, irrespective of the position of the core. This can be considered as a further simplification of the thermal poling technique and the enlargement of its field of application.