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Asymptotic Modeling of Capillary Drawing Process with and Without Preform Rotation

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Extended Abstract

Microstructured optical fibers (MOFs) or "holey" fibers are fibers that contain many holes. More precisely, they contain an array of air holes that encompasses the whole length of the fiber. This new type of fibers nowadays arises great interest, since the hole pattern can be tailored to achieve a wide variety of optical effects that can be exploited to manufacture novel optical devices. The hole pattern can generate either a graded refractive index or a photonic bandgap in the cladding, allowing light guidance within a hollow core. These novel types of fibers have a high potential in a diversity of applications ranging from high-power and energy transmission to telecommunications and optical sensors. They are usually manufactured by heating and drawing down an initial preform in a high-tech temperature furnace. During drawing, the size of the preform greatly reduces and the original hole configuration might result modified leading to undesired effects. On the one hand, during the drawing process, a complex overlapping of thermo-fluid mechanical effects occurs. On the other hand, only a few parameters can be controlled in the fabrication process, for instance, the feed and the draw speed, the internal hole-pressurization, and the furnace peak temperature. Tools that can predict the changes occurring during the drawing process, as well as the final shape and size of the fiber geometry, would significantly aid the MOFs technology. In this regard, mathematical modeling and numerical simulations might become powerful predictive tools. Moreover, they are significantly cheaper than experiments. In this contribution, we extend the work of Taroni *et al.* [1] and derive a new asymptotic energy equation for the drawing of a single annular capillary with and without preform rotation, and we couple it with the asymptotic momentum and evolution equations for the inner and outer radii of Fitt *et al.* [2] and Voyce *et al.* [3]. The whole asymptotic model is based on the small aspect ratio of the capillary. A detailed comparison between the numerical results and the experimental data of Luzi *et al.* [4] and Voyce *et al.* [5] shows excellent agreement, both without inner pressurization and when internal pressure is applied. Although the present models are only valid for annular capillaries, they could serve as a basis to further improve and optimize more complicated but less detailed approaches [6].

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