Tubular Anti-resonant Hollow-core fibers drawing simulation

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Description

This application allows to compute the drawing parameters to realize a tubular hollow-core optical fiber. The method used in this software is that described in the paper of Jasion *et al.* [1] with two minor corrections:

1. Equation 3 has been modified as follow to take into account the fact that the black body radiation is a surface phenomenom and not a volume phenomenom:

$$\frac{\left(R_j^2 - r_j^2\right)}{2}\rho c_p w \frac{dT}{dz} = R_j N \left(T_a - T\right) + R_j \sigma \alpha \left(T_a^4 - T^4\right)$$

2. The viscosity model is based on a more recent paper [2]

There is two tabs in the application:

- The tab "Direct computation" computes the evolution of all the structural fiber parameters during the drawing process with the input chosen by the user.
- The tab "Optimization" computes the pressures and the furnace temperature that allow to obtain a target fiber with a given preform.

Installation

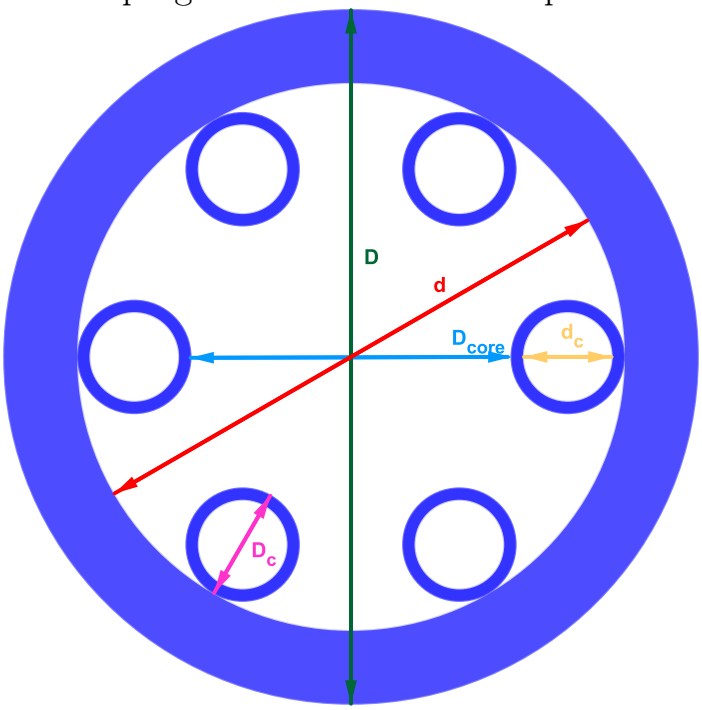
The application has been designed with MATLAB R2019a and its optimization toolbox. It can be launched directly from the source code: the main file is *HARF_ drawing.mlapp*. If you do not have this matlab version/toolbox, an installation file for windows 10 is provided in the release.

Citation

If you use this software in a publication, you can cite it as follow:
O. Vanvincq, "Harf-drawing" (2019), https://doi.org/10.5281/zenodo.3582197

User Manual

All the distances used in the program are shown in the picture below.



List of the parameters used in the program :

- *Pcore* : core pressure
- P_{cap}: overpressure between capillaries and core
- *Feed speed*: speed of the preform
- V_f: drawing speed
- L: computing length. must be greater than the furnace length.
- D_0 and D_f: value of D at $z = 0$ (preform) and $z = L$ (fiber)
- Dc_0 and Dc_f: value of Dc at $z = 0$ (preform) and $z = L$ (fiber)
- d_0 and d_f: value of d at $z = 0$ (preform) and $z = L$ (fiber)
- dc_0 and dc_f: value of dc at $z = 0$ (preform) and $z = L$ (fiber)
- t_f: fiber capillaries thickness, $t_f = (Dc_f - dc_f)/2$
- *Dcore*: fiber core diameter
- *Draw tension*: draw tension at $z = L$
- T_{max}: maximum temperature of the furnace. At $z = 0$, the preform temperature is assumed to be equal to the furnace temperature decreased by 500°C.
- *Furnace length*: must be lower than L. The température outside the furnace is fixed to 20°C.

- *Furnace temperature profile*: function of z that described the evolution of the normalized furnace temperature (T/Tmax) between z=0 and the furnace length
- *Max(Rc/Rcontact)*: if this value is greater than 1, the capillaries are in contact and the fiber is deformed.

References

[1] Gregory T. Jasion, John R. Hayes, Natalie V. Wheeler, Yong Chen, Thomas D. Bradley, David J. Richardson, and Francesco Poletti. Fabrication of tubular anti-resonant hollow core fibers: modelling, draw dynamics and process optimization. *Opt. Express*, 27(15):20567–20582, Jul 2019.

[2] A. Kondratiev and A.V. Khvan. Analysis of viscosity equations relevant to silicate melts and glasses. *Journal of Non-Crystalline Solids*, 432:366–383, 2016.