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Keywords: radiative transfer, Monte Carlo, high-temperature media

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The characterization of new porous materials is critical for various industries such as aviation, space or automobile. The impact of radiative transfer in such media is a central question when high-temperature processes are considered. For instance, radiative transfer has a strong impact on the mechanical properties of thermal barriers protection (for turbine blades or space vehicles during atmosphere re-entry), and therefore a strong impact on the performance of the barriers, such as ceramics, since thermal radiation increases heat transfer [1].

In this work, radiative transfer in high-temperature porous or fibrous semi-transparent media is considered. A predictive code based on the Monte Carlo (MC) method for the radiative transfer equation, along with the solution of Mie theory for the determination of radiative properties has been developed. The null-collision meshless algorithm described in [2] is applied for the treatment of the pores. This algorithm allows to deal with heterogeneous semi-transparent media such as porous or fibrous media, without using a homogenization method. The algorithm consists in introducing in the random generation of photons optical path, null-collision events. Therefore, when a collision occurs, it can be either a scattering phenomena, an absorption or a null-collision event. If it is a nul-collision, it has no consequence on radiative transfer since the photon continues its path like if the collision did not happen. Adding null-collision events allows to deals easily with heterogeneities as shown in [2] since the extinction coefficient, depending on the number of null-collision events, is now arbitrary and can be assumed constant, which facilitates considerably the determination of the collision position in the MC algorithm.

A reverse MC approach is used. It simulates a high number of photons optical path in a reverse way (from the detector until its emission inside the materials). The volumetric fractions are used as probabilities to determine where the photons are located when a collision occurs (if the photons is located in the solid matrix, a pore, a fibre, or a particle). Each times a photon reaches an heterogeneity, the Mie theory is used (the pores or particles are supposed spherical, while the fiber are supposed to be infinite cylinders) to obtain the scattering and absorption coefficients, as well as the phase function. Then the photon optical path random generation continues until its exit of the materials or until it reaches its emission position.

The numerical predicition has been compared against experimental data. The experimental bench dedicated to radiative emission measurements by infrared spectroscopy (FTIR) at high-temperature [3], has been used to perform spectral emission measurements.

In figure 1, the numerical predictions are compared to the experimental measurements for a sample of porous alumina (5% of porosity) at the temperature of $T = 820K$. The numerical predictions are very close to the experimental data. The difference observed between 2000 and $3000cm^{-1}$ may results from the assumptions that the sample is supposed isothermal, nd that the pore are supposed spherical. Moreover, we considered a constant radius for each pores. A distribution of pore radius will be considered in order to improve the simulations and the validation of the code in a fibrous media is in course of development.

In future work, one main objective of this work is to develop an experimental identification method of radiative properties. An inverse method will be applied to identify the unknown properties (such as the complex refractive index, or the absorption and scattering coefficients, and the phase function parameters). The coupling of radiative transfer with others heat transfer modes will also be envisaged in those heterogeneous high-temperature semi-transparent anisothermal media.

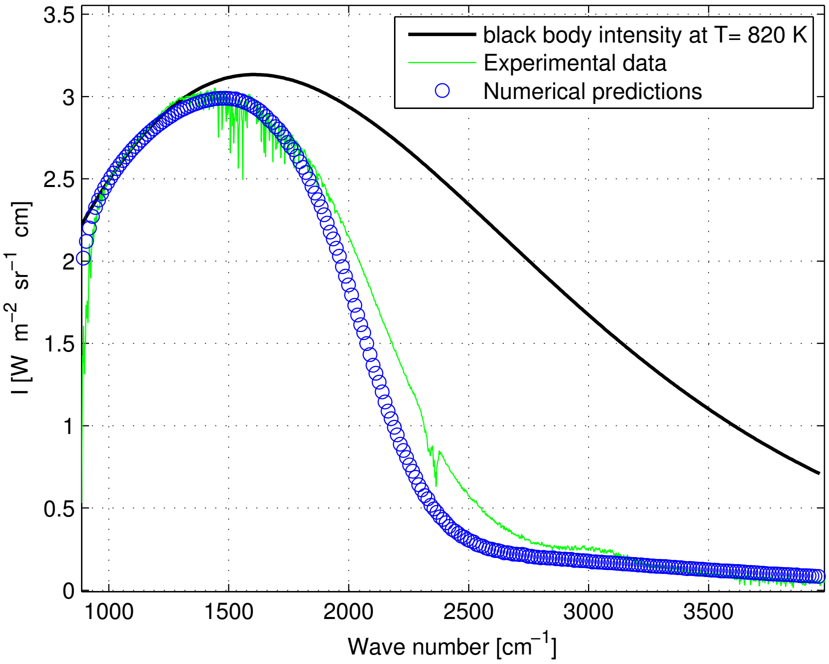

Figure 1: Comparison of the radiative intensities predicted numerically and measured

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