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OPTIMAL MATERIALS AND PROCESSES CONSTRUCTORS BASED ON THE KINETIC THEORY AND MODEL LEARNERS

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Actual design procedures rely on a classical causal path: material, process, properties and induced performances. In order to change of paradigm and finally really reach the desired / optimum performances and stimulate innovation, it should proceed in the opposite way: from performances to properties, from properties to processes and materials. To achieve this, we recently focused on model and system learners able to extract the subjacent and unknown model from the only knowledge of the system state and its evolution, i. e. the system dynamics.

The main drawback of this rationale is related to the nonlinear behaviors. To overcome this issue, it is introduced in the kinetic theory framework as the Fokker-Planck equation allows addressing nonlinear dynamical systems while keeping the linearity of the equation governing the evolution of the probability distribution function defined on the space of the state coordinates. The issue of the inherent curse of dimensionality in this space is circumvented by using advanced dimensionality reduction techniques [1].

In this framework, one can then 1) evaluate all the possible states for a given dynamical system, e.g. its steady state (when it exists), its attractors, etc and 2) proceed to inverse material and process conception and optimization (as proposed in [2]): given the target, obtaining the dynamics, and from both, the state and its dynamics, extracting the model using model learning.

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