AI-BASED MATERIALS AND MANUFACTURING DESIGN

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In the era of Industry 4.0, data-driven modeling is fast becoming the cornerstone of many materials design and discovery efforts, integrating the conventional experimental/theoretical/numerical techniques in a more practical and cost-effective manner. This emerging paradigm, known as *Materials Informatics*, aims to apply high-throughput data-driven techniques in materials science and engineering to accurately predict materials' desired properties primarily based on the dimension-reduced statistical features of their microstructures, along with historical processing data, rather than direct experimentation or time-consuming/high-fidelity simulations. Accordingly, Materials Informatics can be a highly efficient means to discover and apply new processing-structure-property linkages in advanced multifunctional and hierarchal materials. However, to achieve accurate predictive models mapping the effective material properties to controlled process parameters, large and informative manufacturing datasets are required. This entails conducting temporally and financially expensive material processing experiments which can be prohibitive for many applications. As a result, the limited data conundrum currently leads to poor generalization performance of Materials Informatics models, and their scope has been predominantly limited to discovering structure-property linkages. This would be particularly problematic for high-risk decision-making settings, such as aerospace composite manufacturing, where next to the material micro-structure effect, the mechanical properties of formed parts are largely sensitive to the type of processing method and its interacting parameters. One solution to this technological challenge is the development and implementation of the so-called data-efficient (non-data hungry) models, such as transfer learning, multi-fidelity learning and physics-informed machine learning, among others. These models leverage auxiliary sources of data/knowledge such as collected historical data from other relevant processes and established physical laws, to efficiently learn a new process with only a few available data points.

This special session will bring together world experts in the areas of Materials and Manufacturing Informatics to present and discuss together the emerging data-driven methods that can expedite both the discovery of new materials and optimizing their manufacturing processes, while addressing the present limitations of data paucity, along with the underlying material and process uncertainties.

The topics of interest include, but are not limited to:

-Materials informatics

-Smart manufacturing

- Intelligent reverse engineering of products

-AI-based design optimization of materials and structures

-Applications of computational intelligence in manufacturing

-Case studies on non-data hungry smart characterization and processing

-AI-based quantification and modeling of uncertainty in materials and processes