

Dipl.-Ing. Peter Böttner
NEOFORGE
Berlin, Germany



Invited Talk Abstract

Qualify the Process, Not the Part: Physics-Based AI for Additively Manufactured Hydrogen Combustion Hardware

Additive manufacturing enables burner geometries tailored to hydrogen and ammonia flames, from thin-walled swirlers and cooling channels to topology-optimized fuel passages. However, the digital chain from inverse design to functional hardware still breaks down at the manufacturing stage. In laser powder bed fusion, these very features undergo markedly different thermal histories, leading to cracking, distortion, rough surfaces, and variability in material properties, particularly in nickel-base superalloys. Qualification relies on coupon testing that rarely captures the behavior of the actual component, and the process can take years.

This keynote presents an approach that shifts qualification from the part to the process. A physics-based thermal model predicts the temperature field along each scan vector before the build and adjusts laser power vector by vector in real time. Homogenizing the thermal history makes material properties largely independent of geometry, allowing a single qualified process to cover an entire family of designs, including variants generated through inverse optimization loops, using only a fraction of the test specimens required today. The talk explores the implications for high-temperature alloys, the transition from laboratory burners to gas turbine components, and the integration of manufacturing simulation into combustion system design.