In-situ Characterization of the Dynamics in LPBF AM Process by High-speed X-ray Imaging/Diffraction

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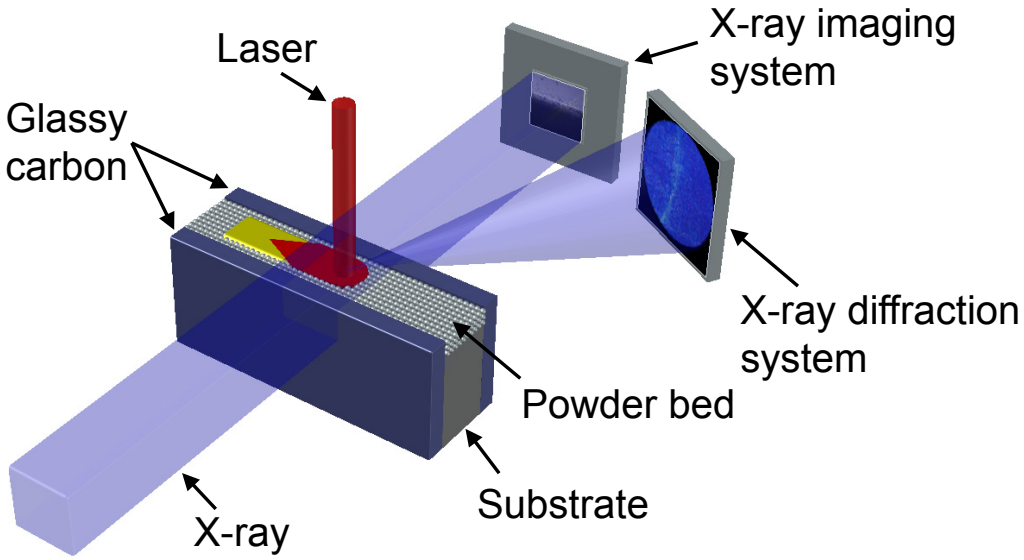
Understanding the dynamics of laser powder bed fusion (LPBF) additive manufacturing process is critical for establishing location-specific processing-microstructure-property relationships. The opacity of metals to visible light and the highly localized (tens of micrometers) and very short (tens of microseconds) interaction of a laser beam with metal powders/substrate during LPBF processing pose a huge challenge to the characterization and understanding of this process. The detailed mechanisms underlying the LPBF process are still not fully understood. In this talk, I give an overview of our research on characterizing the dynamics of powder spreading, powder spattering, melt pool evolution, melt flow, defect formation and evolution, and solidification in LPBF additive manufacturing process by using high-energy high-speed x-ray imaging and diffraction. The results obtained in this work are important for (1) establishing the location-specific processing-microstructure-property relationships in LPBF of metals, (2) developing and validating computational models, and (3) guiding the development of real-time process monitoring technique, as well as qualification and certification tools.

High-speed high-energy x-ray imaging/diffraction



APS 32-ID-B, X-ray energy: 24 keV, resolution: up to 1 μm, frame rate: up to 6.5 MHz, exposure time: down to100 ps

- **Developed the in-situ characterization system**
- **Quantitatively studied the dynamics of:**
  - Powder spreading
  - Powder spattering
  - Melt pool evolution
  - Pore dynamics
  - Solidification