High-Speed Tensile Testing

Localized Strain Evaluation Using High-Speed DIC

Uniaxial tensile testing is the most widely used material testing method in practice. During a **tensile test**, an axial force is applied to a sample until failure to derive crucial mechanical properties such as strength, elasticity, and ductility. Analyzing load-to-displacement data allows engineers to generate stress-strain graphs, providing key design parameters like yield strength, ultimate tensile strength (UTS), and Young's modulus.

This case study was conducted in collaboration with our Austrian partner, **4A engineering**. The strain data computed by **Mercury RT** serves as a vital input for generating validated material cards.

Objective

The primary objective of this study was to evaluate and quantify the **localized strain** on a standardized specimen subjected to **high-speed deformation** under dynamic loading conditions.

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Description of the Case Study

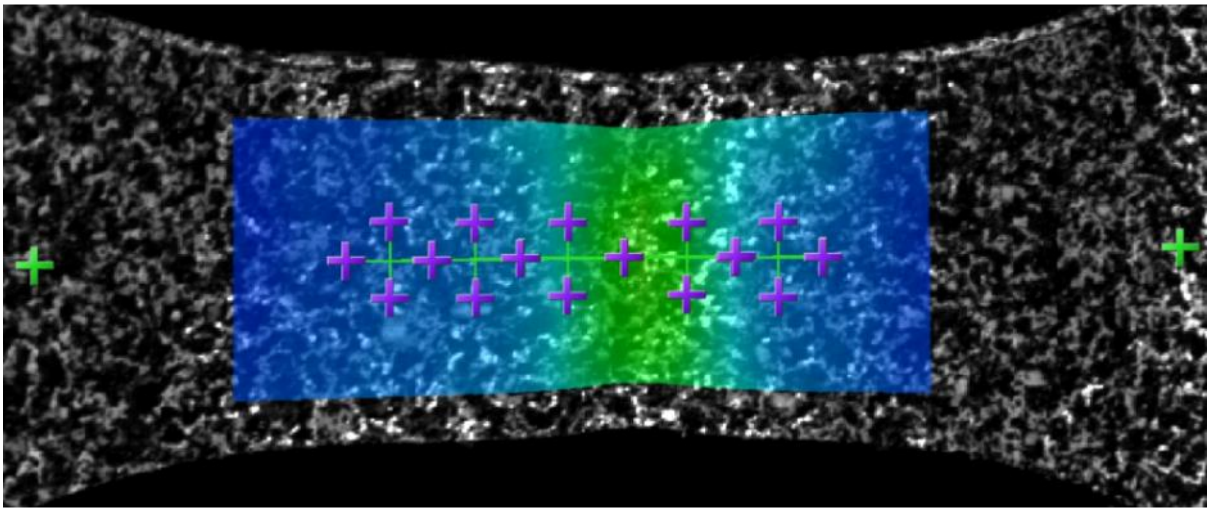
The experiment was performed on a standardized test specimen subjected to uniaxial force. The highly dynamic technical setup included:

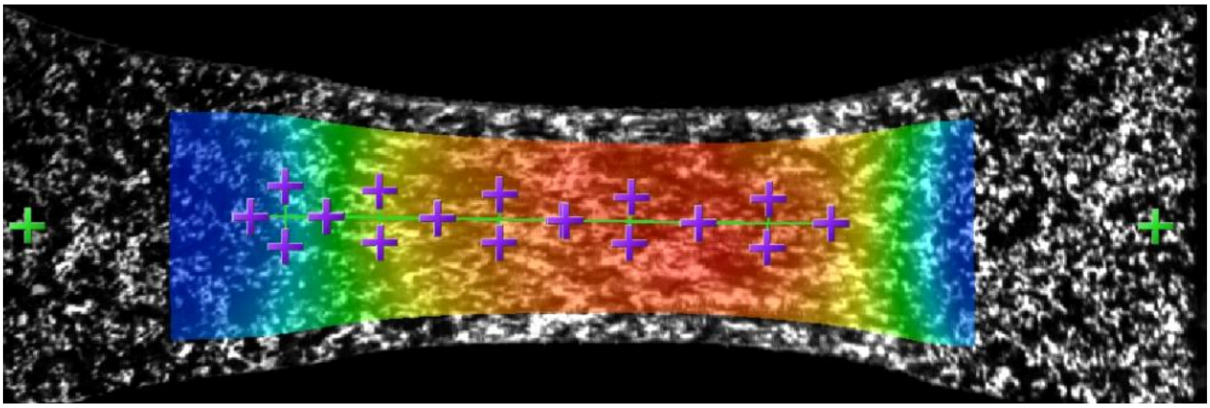
- **Testing Machine:** 4A engineering's **Linovis** dynamic testing machine, capable of reaching testing speeds up to **3.2 m/s**, a maximum force of **25 kN**, and a maximum stroke of **200 mm**.
- **Optical Setup:** A 2D Digital Image Correlation (DIC) system utilizing a **Photron Nova S9** high-speed camera paired with a high-fidelity **Zeiss 100 mm** lens.
- **Image Acquisition:** The camera captured the event at a resolution of **896 x 240 px** with an ultra-high frame rate of **40,000 fps**.
- **Testing Speed:** This specific configuration allowed the system to precisely record localized strain at a testing speed of **2 m/s**.

Results

The Mercury RT DIC software successfully processed the high-speed imagery, delivering comprehensive insights into the material behavior:

- **Full-Field Strain Mapping:** Provided clear graphical visualizations along with precise quantitative data mapping the material's structural response to rapid, dynamic loading.
- **Multi-Point Tracking:** Handled virtual extensometers to track elongation between two points at multiple critical locations across the sample surface.
- **Simulation Material Cards:** The computed high-fidelity strain data was imported into **Valimat** (4A engineering's proprietary software) to generate fully validated material cards for finite element analysis (FEA).





Advantages of Using DIC in High-Speed Testing

- **Precision under Extreme Conditions:** Accurately evaluates strain distribution even under rapid, volatile deformation rates.
- **Full-Field vs. Single Point:** Unlike traditional mechanical extensometers, DIC captures full-field strain gradients, revealing localized deformation and necking behavior.
- **Non-Contact Measurement:** Eliminates the risk of knife-edge slippage or physical sensor damage during violent high-speed material failures.
- **Seamless Workflow Integration:** Directly bridges the gap between physical impact testing and digital material simulation.