Colorado Science and Engineering Fair

2025 Individual Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: Development of Digital Image Correlation Software to Evaluate Mechanical Properties of 3D-printed Polymers for Sustainable Material Innovation

Finalist's Name: Jude Le Chen

School and City: Fairview High School, Boulder

Sponsor's Name: Hemant Sethi

Category: Engineering

Division: Senior (grades 9 - 12)

Abstract (250 words or less):

Covalent Adaptable Networks (CANs) bridge the gap between thermosets and thermoplastics by enabling dynamic covalent bond exchange, which facilitates reprocessing, self-healing, and recyclability. This research aims to determine the optimal crosslink density for maximizing CAN mechanical strength, using 3D-printed polymeric materials as a baseline model for future CAN development. A notable real-world application is the reduction of wind turbine waste by enabling on-site construction, repair, and recycling, thereby minimizing negative environmental and transportation impacts. This would increase efficiency as well as the elimination of wind turbine dumps. To achieve this, we developed custom Digital Image Correlation (DIC) software using the pyDIC module to track strain distribution and deformation mechanics under uniaxial tensile loading along the x-axis. High-speed image acquisition is synchronized with an Instron mechanical testing system to quantify stress-strain behavior. Filament orientations at 0°, 45°, and 90° are analyzed to assess anisotropic mechanical responses, leveraging speckle patterns for enhanced DIC accuracy. Data acquisition focuses on stress-strain relationships, displacement fields, and modulus determination to inform CAN tunability. The two notable calculations used for statistical analysis are Poisson's ratio and Young's modulus, both of which are necessary for determining a material's tensile properties. Preliminary results confirm that 2D-DIC provides a reliable framework for evaluating polymer deformation and common fracture points. Ongoing analysis will refine mechanical interpretations, with findings to be presented at the upcoming fair. By integrating DIC with mechanical testing, this research supports sustainable polymer innovation, offering scalable solutions for enhancing self-healing materials, the durability of wind energy and beyond.

I hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I also attest that the above properly reflects my own work.

Finalist's Signature: Date:

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with you Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**