NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Cycle 20
January 2026

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Project Title.
Femtosecond Laser Processing for Direct Bonding of Thermoplastics and Metals in Wind Turbines

Abstract.
Wind turbine blades are produced by bonding a small number of components with adhesives, but cracking and de-bonding of adhesive joints are major contributors to blade failure. Furthermore, thermoset composites are the typical material of choice for turbine blades, but thermosets cannot be repaired, be welded for joining parts, nor recycled into new blade components. There is currently increasing interest in switching to thermoplastic-based composites, which also exhibit excellent mechanical and stability properties but have potential to enable welding without adhesives, in-situ repairs, and recycling of blade materials. However, the high pressures and temperatures needed to weld thermoplastics are challenging to apply when joining large components, and bonding of thermoplastics to other materials is currently limited by poor adhesion and failure under mild loads.

To overcome these challenges, the research objective of this proposal is to develop an innovative method to achieve strong adhesion of thermoplastic polymers through the use of an intermediate, femtosecond laser surface-processed metallic component. Well-controlled micro-and nano-structures will be created to induce superwicking and welding at mild conditions, with geometries tailored to resist the complex mechanical loadings expected during wind turbine service. This research will yield exceptional mechanical performance, decrease manufacturing costs, and allow in-situ repair and recycling of wind turbine blades.