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WINTER 2026

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spe COMPOSITES
WINTER 2026

Composites Connection™
Advancing Composites Technology Worldwide

Chairman's Message:

Dale Brosius

Dear Composites Division members,

As I reflect on the year that was 2025, it was a story of two trajectories for composites, depending on whether you live in the U.S. or outside the U.S. Going into the year, there was global momentum for the electrification of the vehicle fleet, efforts in developing green hydrogen, and rapid growth of wind and solar power, driven by quickly escalating demand for data processing for AI and other technologies.

Countries outside the U.S., notably China and those in Europe, continued to support these transitions (China is far and away the largest producer of electric vehicles and in the installation of new wind capacity annually, including offshore wind). Conversely, the incoming administration in the U.S. has made it very clear it does not favor electric vehicles or clean energy technologies like wind, solar and hydrogen. It has actively cut research, development and demonstration (RD&D) funding in these areas, and has sought to cancel offshore wind farm leases, although there are many legal challenges ahead. Conversely, the administration is supporting investment in small nuclear reactors, geothermal technologies, and enhanced oil and gas exploration.

So what impact will this have on composites and our roles within the composites industry? It's yet to be seen whether these changes are relatively short term, or will have long term consequences, but major OEMs in the automotive, aerospace and power generation markets are global entities, so I believe composites growth will still occur and new innovations will still be needed. Land based wind farms, financed by private companies and utilities, will continue to be built, but the US will fall behind the rest of the world in overall implementation of clean energy, where growth should continue strongly.

In automotive, lightweighting, whether for EVs, hybrids or combustion powertrains will always be in favor, and there are continued opportunities for composites and plastics engineers to improve cycle times, part integration and multi-functionalization whatever the power source.

The latest edition of the SPE Automotive Composites Conference and Exhibition was held September 3-5, 2025 in Novi, Michigan. Reflecting on the 25 years of the conference, it was clear that composites have thrived through various eras of fuel economy regulations, powertrain changes and customer preferences. The 2026 edition, September 9-10 in Novi, promises to once again deliver great content, novel insights, robust discussions and ample time for networking with fellow composites enthusiasts. I encourage all of you to bring your latest technologies, present them and display them.

I thank each of you for your continued membership and support of the Society and the Division. Best wishes for a prosperous and innovative 2026!

Best regards,
Dale Brosius
Chair, SPE Composites Division

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Award Report

By: Vipin Kumar, Ph.D. Award Chair

Part of the mandate of the Society of Plastics Engineers – Composites Division is to recognize excellence in composite materials development and proliferation. Several awards have been organized for this purpose to honor and recognize such individuals, both on academic and industrial levels. Every year the Composites Division issues these awards are based on rigorous competitions through solicitation of nominees and applicants. The awards are a) Harold Giles Award, b) Jackie Rehkpof Scholarship, c) Travel Award, and d) Educator of the Year Award. Other non-financial awards that are open to nominations as of January 1st are a) Honored Service Member / SPE Fellow and b) Composite Division Person of the Year Award. These two awards aim to recognize distinguished contributions from dedicated members of the society.

Harold Giles Scholarships

This award was created in honor of the late Harold Giles who was taken from this world too soon. Harold was one of the best Composite Division Awards Chairs that many of us worked with during his days at Azdel and at UNC. He would have been thrilled to know that we are honoring his name in awarding worthy students. This award is run through SPE International in their Foundation Program series. The Composites Division will select the winners from the pool of applicants in two categories, Graduate and Undergraduate students. The award is dispensed through SPE International to the winners.

The scoring criterion is based on twenty points for the category of scholastic achievements, community service, and other honors, up to ten points based on the strength of the recommendation letters, ten points for previous employment history particularly if this involved composite activity, up to five points for filling out the application form correctly and using good English, five points for providing their transcript and for getting good grades, and a final five points for the reason they applied for the scholarship.

Award Requirements:

- Two awards presented to one undergraduate and one graduate student, who will maintain the academic status for at least two semesters after award announcement.
- An essay documenting experience in the composites industry is required (courses taken, research conducted, or jobs held)
- Have not received the award in previous years.

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This Issue:

Award Report continued...

- Winners are typically students who not only maintained a good grade point average but also served their community, had some experience in the composite area, and are backed by solid reference letters from former professors and employers

The award can be up to $3500 per student depending on funding availability.

Key Dates:
Issue call for nominations February 1st
Close call for nominations April 31st
Complete award adjudication June 30th
Notify recipients by July 30th
Present awards SPE ACCE

Dr. Jackie Rehkopf Memorial Scholarships
This award is in honor of the late Jackie Rehkopf who was a recognized engineer who published books and was actively involved in the composites industry. The Automotive and Composites Divisions co-sponsor these awards and therefore co-coordinate. This award is presented annually at the SPE ACCE conference each fall and is a premiere award for exemplary performance.

Award Requirements

- A single full time grad student or two undergrad students if no grad students qualify
- Female candidates are strongly encouraged to apply
- Focus should be on research activities targeted to ground transportation composite technology
- Students must be in good academic standing and pursuing a degree in Polymer Science, Composites, Plastics, or a related Engineering discipline
- A 2-page essay is required showing planned work and how it will benefit composites in an automotive or other ground transportation application
- A letter of recommendation from the student's advisor or mentor is also required
- Scholarship recipients are required to present work at an SPE technical conference and/or have it published in an SPE technical journal

The award can be up to $5000 if one student is selected or up to $2500 per student if two are selected, depending on funding availability.

Key Dates
Issue call for nominations January 1st
Close call for nominations April 31st
Complete award adjudication June 30th
Notify recipients by July 30th
Present awards SPE ACCE

Call for Papers, Sponsors & Exhibitors

For Immediate Release: 5 December 2025

Media Contact: Teri Chouinard,
SPE Thermoset TopCon Event Manager,
248.701.8003, intuitgroup@gmail.com

SPE® Thermoset Div. Announces Call For Papers, Sponsors & Exhibitors For Thermoset Topcon May 12-13, 2026 In Madison, Wisconsin

"The Future of Thermosets: AI And Emerging Industry Innovations"

- How Artificial Intelligence Will Benefit the Thermoset Industry
- New Thermoset Manufacturing and Material Developments
- Industry Alliances and Working Together to Grow the Thermoset Market

Abstracts Due February 17, 2026 & Final Presentations Due April 17, 2026

Please send Abstracts including Title and Description (100 – 200 words) to: intuitgroup@gmail.com

The SPE Thermoset Div. is announcing its call for papers, exhibitors, and sponsors for their annual event to be held on May 12 – May 13, 2026 at the Monona Terrace and Convention Center in Madison, Wisconsin.

"The Future of Thermosets and Emerging Industry Innovations" is the theme for the 2026 event. "Advancements in AI are speeding developments in all industries and this year's SPE Thermoset TopCon will highlight how the thermoset industry can benefit from this growing technology," said Sean Campbell, sales and marketing manager, Engineered Composites at LyondellBasell and SPE Thermoset Div. Chair. "We are planning to bring in AI industry experts to present how the technology is changing the world overall, include specific applications to benefit the thermoset industry, and inform attendees on how to use and apply AI to benefit themselves and their companies," added Campbell. "In addition, industry associations will update us on what they're doing to benefit our industry and how we can help," added Campbell.

The SPE Thermoset TopCon 2025 event was a huge success including 30 Sponsorships and/or Exhibits, nearly 200 Registrations, 19 Technical Presentations, Two Keynote Addresses, an Executive Roundtable and 5 Student Posters.

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This Issue:

Call for Papers, Sponsors continued...

The SPE Thermoset TopCon 2026 will follow the 2025 format featuring keynotes, technical presentations and exhibits highlighting advances in materials, processes, and equipment for thermoset technologies in multiple applications. The 2-day conference also includes networking breakfasts, lunches, and a cocktail reception. Optional social events, including a tour of the Polymer Engineering Center at UW – Madison, golf outing at University Ridge Golf Course and a cruise of the Madison shoreline are offered on May 11, the day before the conference begins.

A variety of exhibit and non-exhibit sponsorship packages including passes to the event and opportunities for company exposure are available. Companies interested in presenting papers and/or showcasing their products and/or services via sponsorship or exhibiting, and individuals interested in registering to attend the event should go to https://spethermosets.org/topcon/ for more information or contact Teri Chouinard at intuitgroup@gmail.com.

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Presented by SPE Automotive and Composites Divisions

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SPONSORSHIP & EXHIBIT OPTIONS offer companies the opportunity to support the event and promote their products and services to a very targeted and interested OEM audience. Contact Teri at **intuitgroup@gmail.com** or **248.701.8003** and see our website **https://speautomotive.com/acce-conference/** for more information.

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SPE® ACCE 2025 Highlights 25 Years of Advancing Mobility with Composites

FOR IMMEDIATE RELEASE: 2 OCTOBER 2025

Media Contact: Teri Chouinard, SPE ACCE MarCom Chair, 248.701.8003, intuitgroup@gmail.com

SPE® Automotive Composites Conference & Expo (ACCE) 2025 included 73 Technical Presentations, 25 Student Posters, 43 Sponsorships, 32 Exhibits, 4 Keynote Addresses and a panel discussion on the Evolution of the Industry and Composites Over the Past 25 Years of ACCE.

In addition, more than $13,000 was awarded in student scholarships & 25 students were provided with free registrations and hotel accommodations

TROY (DETROIT), MICH. -
The SPE® Automotive Composites Conference & Expo (ACCE) event was held September 3 – 5, 2025, at the Suburban Collection Showplace Diamond Banquet and Conference Center in Novi, Michigan. It was the 25th anniversary of the SPE® ACCE produced by the SPE Automotive and Composites Divisions. The conference provided a unique space for networking, technical exchange, and showcasing innovations shaping the future of automotive composites.

"The presentations in the technical program were excellent this year, including the poster presentation by the students. It was great to see the students showcased and the direction the composites industry is headed in," said Anthony Console, Sale Leader, Owens Corning. "There was very good booth traffic, and we had activity at our booth constantly. It was great to see such a high level of engagement and interest in our offerings," added Laura Strange, Sales Leader, Owens Corning.

"This year's 25th Anniversary of the ACCE was the best yet!" said Eric Haiss, Senior Business Development and Engineering Executive, IDI Composites International," "We saw nearly every major North American OEM, with all of them having multiple people in attendance," Haiss added.

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On the Exhibit Floor

This Issue:

ACCE 2025 Highlights continued...

"The turnout at the 25th Anniversary ACCE has been great to see," said Greg Spaeth, Project Engineer, Plastics Engineering Company (PLENCO) and SPE Thermoset Division Board Member. "It's clear that ACCE remains a key place for building connections, sharing expertise, and shaping the future of composites," added Spaeth.

ACCE Leadership & Summary:

"As we celebrate 25 Years of Advancing Mobility at ACCE 2025, I'm delighted to see both familiar faces and new pioneers coming together," said Dr. David Jack, Professor – Department of Mechanical Engineering at Baylor University and ACCE 2025 Co-Chair. "Over the past quarter-century, composites have evolved from promising materials to essential enablers of innovation—in automotive, aerospace, sustainable transport, and beyond. Looking ahead, we continue to drive solutions that are lighter, stronger, more efficient—and that push the boundaries of mobility in all its forms."

"This year's ACCE showcases how far composites have come over the past 25 years—transforming from emerging materials into indispensable solutions for mobility and beyond," said Dr. Mike Siwajek, Vice President of Research and Development at CSP and ACCE 2025 Co-Chair. "Advances in materials and manufacturing are unlocking even greater possibilities for performance, sustainability, and design freedom, and it's exciting to see our industry driving the next wave of innovation together."

A number of composite leaders from industry and academia provided additional direction and support for the event. The technical program included 73 presentations and was led by Dr. Hendrik Mainka, Principal Program Lead and Head of Volkswagen Group Innovation Hub, Knoxville and Dr. Dominik Dörr, Co-Founder & Managing Director of Simutence. Additional support was provided from Jitesh Desai, Program Treasurer for the SPE Automotive Division. Dr. Leonardo Simon, Professor at the University of Waterloo, led the ACCE Parts Competition that included 10 nominations. Dr. Douglas Smith, Professor at Baylor University, Chair of Student Engagement, led the Student Poster Competition that included 25 presentations and 23 mini oral presentations. Teri Chouinard,

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ACCE 2025 Highlights continued...

President of Intuit Group, provided leadership as ACCE Sponsorship Chair with 43 sponsorships and 32 exhibits and provided Admin support for the Technical Program and Event Management overall.

Keynotes presented at the ACCE 2025 event included:

"Composites Enable Innovative, Efficient, and Recyclable Vehicles and Can Help to Change the Nature of Mass Production" by Casey Putsch, President, Genius Garage Educational Programs, "Composites and Circular Vehicle Technologies at Volkswagen Group Innovation" by Kristin von Szadkowski, Lead Sustainable Product Innovation, Volkswagen AG, "Decade of Innovation: IACMI's Impact" by Chad Duty, CEO, IACMI, and "Balancing Multiple Objectives in Composites Design" by Amanda Nummy, Senior Polymer Materials Engineer, Hyundai America Technical Center Inc.

A Panel Discussion on "The Evolution of the Industry and Composites Over the Past 25 Years of ACCE," was moderated by Dale Brosius, President of Brosius Management Consulting & Commercialization Manager at IACMI. Panelists included Frank Henning, Institute Director at Fraunhofer ICT, Michael Connolly, Consultant at MC Material Design, Alper Kiziltas, Senior Advanced Materials Engineer at Amazon, Mike Siwajek, Vice President of Research and Development at CSP and David Jack, Graduate Program Director for Baylor's Materials Science and Engineering program. Their perspectives highlighted both the remarkable progress made in composite technology and the collaborative innovations still needed to drive the industry toward a more sustainable future.

The ACCE 2025 technical program included 73 presentations on advances in the following categories: Additive Manufacturing & 3D Printing, Advances in Thermoplastics Composites, Advances in Thermoset Composites, Bonding, Joining & Finishing, AI/Machine Learning & Data Driven Solutions, Carbon Composites & Reinforcements, Composites in Electric Vehicles, Enabling Technologies, Sustainable Composites, Design, Modeling, and Simulations of Composites.

Best Paper Awards:

Excellence in technical writing is recognized annually at ACCE by honoring those who have presented the best papers at the conference. The 2025 Best Paper Award winners received the highest average ratings by conference peer reviewers, including members of the ACCE planning committee and other industry experts. First, second, and third place winners were recognized and honored at the event in the "Best Paper Award" competition. Tymon Nieduzak, a PhD student at Columbia University, won the Best Paper Award for his paper "Multi-functional Composites for Battery Enclosure Structures – Self-Health Monitoring Technology". Second place recognition was awarded to Rishabh Pammi, PhD student at Purdue University, for his paper "Compression Properties and Impact Energy Absorption of Carbon Fiber-Reinforced Composite Honeycomb Core for Automotive Structural Applications." Third place recognition was awarded to Clayton Hearn, a PhD student at Baylor University for his paper "Automated tracking and identification of ply-drops in tapered composite laminates through ultrasonic testing".

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This Issue:

ACCE 2025 Highlights continued...

At the conference, the authors received certificates, and their papers were highlighted in the ACCE program schedule. Their papers will also be published in the SPE Automotive and Composites Division newsletters and other industry publications.

Student Poster Competition:
Students from the across the United States featured innovative research related to polymer composite materials and manufacturing technologies for automotive applications via the annual ACCE Poster Competition. This yearly event enables students to meet with industry professionals and learn about career opportunities as a scientist, engineer, researcher and other professions in the field. Automotive OEMs, tier suppliers, and others appreciate the introduction to the next generation of automotive composites engineering professionals and the opportunity to potentially hire them in the future. Dr. Douglas Smith, Professor at Baylor University, led the Student Poster Competition again this year. The 2025 ACCE Student Poster Competition included 25 posters from 10 different universities and two high schools. 23 students also gave mini-oral 5 minute presentations to conference attendees to share their research.

This year's poster competition winners are:

Graduate Category:
1st Place: "Multifunctional Composites – Self-Health Monitoring Technology Smart Electric Vehicle Battery Enclosure" Tymon Nieduzak, Columbia University

2nd Place: "Rapid Inspections Using Flash Thermography to Identify and Quantify BVID in CFRPs" Gabriela Meriano, Baylor University

3rd Place: "Automation with AI: Improving the Quantification of Barely Visible Impact Damage in CFRP Laminates from Ultrasonic Testing Data" Rachel Van Lear, Baylor University

High School / Undergraduate Category:
1st Place: "Exploring Effects of Additives on the Thermal Stability and Processability of Polypropylene for Use in Paper-Fiber Polypropylene Composites with Automotive Applications" Jocelyn Hess, University of Tennessee, Knoxville

2nd Place: "Advancement of Bio-Based Natural Fiber-Polyurethane Sandwich Panels with Corrugated Paper Core for Automotive Interiors" Muna Shakour, Pioneer High School, University of Michigan

3rd Place: "Additive Manufacturing with Hybrid Continuous and Discontinuous Fiber Systems" Thomas Schmitz, Purdue University

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This Issue:

ACCE 2025 Highlights continued...

Scholarship Awards:
The ACCE Scholarships (a total of $8,000 USD) are sponsored by the SPE Automotive and SPE Composites Divisions. Five ACCE Scholarships ($1,000- $2,000 USD each) are awarded to students pursuing advanced studies in a composites-related field. The ACCE Scholarship Committee was led by Assoc. Prof. Zeynep Iyigundogdu, Adana Alparslan Türkeş Science and Technology University, Dr. Alper Kiziltas, Sr. Advanced Materials Engineer, Amazon Lab126 and Drew Geda – Senior Polymer Materials Development Engineer – Hyundai America Technical Center, Inc.

The five winners of the SPE ACCE scholarships are Akash Padatare, a PhD Student in Mechanical Engineering at the University of Tennessee in Knoxville, TN was awarded $2,000; Kunle Adeyemo, a Dual-Degree PhD Student in the Department of Civil & Environmental Engineering and the Department of Mechanical Engineering at Michigan State University in East Lansing, MI awarded was $2,000; Eonyeon Jo, a PhD student in Sustainable and Advanced Composite Material Manufacturing at the University of Tennessee, Knoxville in Knoxville, TN awarded $2,000; Malik Hassan, a PhD student in Biological Engineering at the University of Guelph, in Guelph, Ontario was awarded $1,000; and Jocelyn Hess, an Undergraduate Student in Materials Science & Engineering at the University of Tennessee, Knoxville in Knoxville, TN was also awarded $1,000.

The Dr. Jackie Rehkopf Scholarships (a total of $5,000) are sponsored by the SPE Automotive Division, the SPE Composites Division and the generous donations of friends and family. Three winners selected this year for the Rehkopf Scholarship are Kendra Allen, a PhD Student in Energy Science and Engineering at the University of Tennessee, Knoxville, in Knoxville, TN was awarded $2,000; Clara Kramer, a PhD Student in Chemical and Biological Engineering at the University of British Columbia, in Vancouver, BC was awarded $1,500; and Gabriela Meriano, a PhD Student in Materials Science and Engineering at Baylor University in Waco, TX also awarded $1,500.

Part Competition:
This year's ACCE Part Competition was led once again by Dr. Leonardo Simon from the University of Waterloo, who previously served as the 2021, 2022 and 2023 ACCE Co-Chair. A panel of automotive composites industry experts, from industry and academia, studied the 10 nominations that were submitted in advance of the event and reviewed the parts onsite and voted for the Most Innovative Material and/or Process Applications in Production Part and Prototype Part Categories.

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ACCE Scholarship Recipients

This Issue:

ACCE 2025 Highlights continued...

Nominations were judged on the impact and trendsetting nature of the application, including materials of construction, processing methods, assembly methods, and other enabling technologies that made the application possible. Nominations emphasized the benefits of design, weight and cost reduction, functional integration, and improved performance. A separate prize, the People's Choice award, was selected by vote of conference attendees.

Here are the winners:

1. Most Innovative Part in the Process Innovation - Prototype Part Category:
LFT-Tape-Sandwhich Underbody Demonstrator with Rib Pressing, submitted by Simutence

2. Most Innovative Part in the Process Innovation – Production Part Category:
Large Format, Structural CFRTP Truck Bed Liner, submitted by Re:Build Manufacturing

3. Most Innovative Production Part in Materials Innovation:
Multifunctional Composite EV Battery Enclosure, submitted by General Motors, CSP

4. Most Innovative Prototype Part Materials Innovation:
Thermoplastic Structural Sandwich Battery Enclosure, submitted by Kautex

5. People's Choice Award:
Volkswagen ID.4 Interior Door Handle Bezel, submitted by Baylor University and Volkswagen North America Group in the Process Innovation - Prototype Category.

ACCE Sponsors:

The 2025 SPE Automotive Composites Conference & Expo (ACCE) was made possible by the support of Sponsors including:

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Held annually in suburban Detroit, the ACCE currently draws approximately 400 speakers, exhibitors, sponsors and attendees and provides an environment dedicated solely to discussion, education and networking about advances in transportation composites. Its global appeal is evident in the diversity of exhibitors, speakers, and attendees who come to the conference from Europe, the Middle East, Africa, Asia/Pacific and South America as well as North America. About 20% of attendees work for automotive and light truck, agriculture, truck & bus or aviation OEMs and another 25% represent tier suppliers. Attendees also work for composite materials processing equipment, additives, or reinforcement

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This Issue:

ACCE 2025 Highlights continued...

suppliers; trade associations, consultancies, university and government labs; media; and investment banks. ACCE has been jointly produced by the SPE Automotive and Composites Divisions since 2001.

For more info on ACCE go to: https://speautomotive.com/acce-conference/.
The mission of SPE is to promote scientific and engineering knowledge relating to plastics worldwide and to educate industry, academia, and the public about these advances. SPE's Automotive Division is active in educating, promoting, recognizing, and communicating technical accomplishments in all phases of plastics and plastic-based composite developments in the global transportation industry. SPE's Composites Division does the same with a focus on plastic-based composites in multiple industries. Topic areas include applications, materials, processing, equipment, tooling, design, and development.

For more info go to: https://speautomotive.com/ and https://composites.4spe.org/. For more information on the Society of Plastics Engineers, see www.4spe.org.

The next ACCE is scheduled for Sept. 9 – 10, 2026. An "Early Bird Discount" is available to sponsors who commit to supporting the ACCE 2026 event in 2025 and process payment by December 31, 2025. For more info contact Intuitgroup@gmail.com

This Issue:

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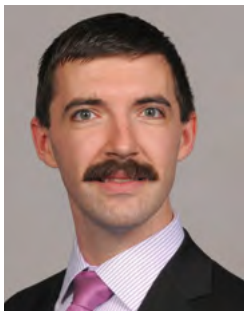

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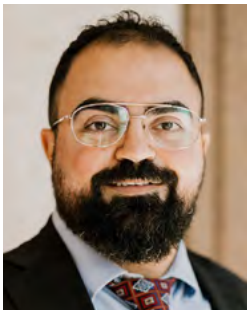

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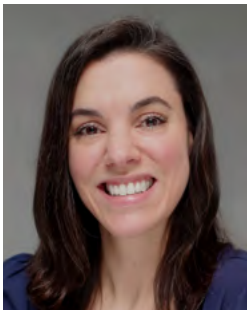

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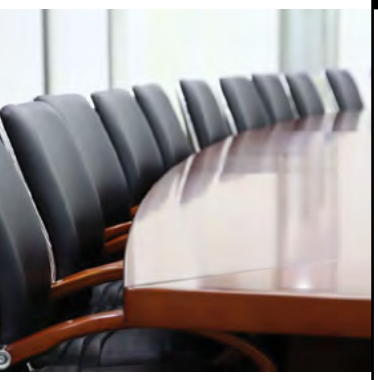

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Automated Tracking and Identification of Ply-Drops In Tapered Composite Laminates Through Ultrasonic Testing

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Abstract

To achieve complex geometries of composite laminates and optimal layup configurations while reducing both cost and structural mass, the thickness of a composite laminate is often not held consistent throughout the part. Designers often call out the addition or termination of a lamina within a composite laminate, often termed a ply-drop. This current work focuses on the identification and tracking of ply-drops in composite laminates using a novel ultrasound technique. An automated algorithm developed to generate a map of the ply-drops inside the part is discussed. Results are presented to demonstrate the effectiveness in tracking the correct location of the ply drop, both the specific plies and their effective planar locations. The envisioned application is in the manufacturing environment to confirm the proper placement of a designed ply-drop, while also capturing an unintended and unwanted ply-drop.

Introduction

Carbon fiber reinforced polymers (CFRP) are used across the automotive and aerospace industries due to their high strength-to-weight ratio [1]. Oftentimes, the thickness of the part is varied throughout by terminating a lamina within the part, and is termed a ply-drop. Ply-drops are oftentimes implemented in parts to optimize the design criteria that are needed for specific loading and use scenarios [2]. Even though ply-drops provide design benefits and allow for custom and unique part geometries, they do have some downsides when they occur unintentionally. For example, ply-drops are more likely to cause delamination than parts of a uniform thickness. Similarly, the ply orientation of the plies dropped with respect to the entire part influences the loss of structural properties compared to a uniform thickness part [3,4]. In addition, the fatigue life of a composite laminate with a ply-drop is significantly decreased compared to the fatigue life without the presence of a ply-drop [5]. This is due to a resin rich pocket forming where the drop occurs, which corresponds to a lack of fiber reinforcement at the drop location [6]. For the present paper, the ply-drops of interest are only those that occur in the interior of the part, thus they are not visible from the outside of a part. Consequently, ply-drops must be inspected using non-destructive techniques to confirm that the parts were manufactured correctly and that there are no errant ply-drops within the part [7].

Various non-destructive test methods can be used to inspect carbon fiber laminates. X-ray computed tomography (CT) is considered the most reliable and effective at identifying defects and properties of composite laminates [8], but it is not a very practical method for use in industry. CT machines are large, costly to operate, and can only look at individual small standalone parts. For looking at parts that are attached to a large assembly, such as an automobile or aircraft, it is often desirable to have a portable technology that can perform its inspection by only needing access to one side of the part. Another common method for inspection is the use of eddy currents, but these are often limited to the identification of cracks in carbon fiber composites, and its use is limited due to the low and inconsistent conductivity across a carbon fiber laminate [9].

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Pulse echo ultrasound is commonly used for quality control across many industries including the electrical, structural, and petro-chemical industries, and only needs access to one side of the material [10]. For composite specific applications, pulse echo ultrasound has been used to detect damage and defects such as barely visible impact damage (BVID) and foreign object debris (FOD) [11,12]. Smith et al. have used ultrasound inspection to try and track ply-drops throughout a part. They developed a computational model to demonstrate their concept and was quite effective in capturing the ply-drops, but when used in the experimental domain on a physical component the ply-drops were not consistently identified [13]. The present work presents an approach using ultrasound to identify the location of a ply-drop in a carbon fiber laminate. Specifically, experimental results are presented to demonstrate the approach and the results capturing the specific ply-drop location is consistent with the expected ply drops.

Carbon Fiber Laminate Manufacturing

For this study, two carbon fiber reinforced polymer parts were manufactured with a custom vacuum assisted resin transfer method. The dry fabric is a plain weave 6oz Toray T700 with a 3k tow. The resin is PRO-SET's INF-114 infusion resin mixed with the INF-211 hardener. The first part is a 15 lamina composite with the 4th layer dropped, and the second part is a 9 lamina composite with the 5th layer dropped. For both parts, the ply orientation is alternated between 0° and 45°, with the first and last laminas in the stack being 0°. The 15 lamina composite was initially manufactured as a 101mm x 152 mm part with the ply-drop occurring horizontally across the part as shown in Figure 1 and sectioned to 89 mm x 140 mm with a Wazer Desktop Waterjet cutter.

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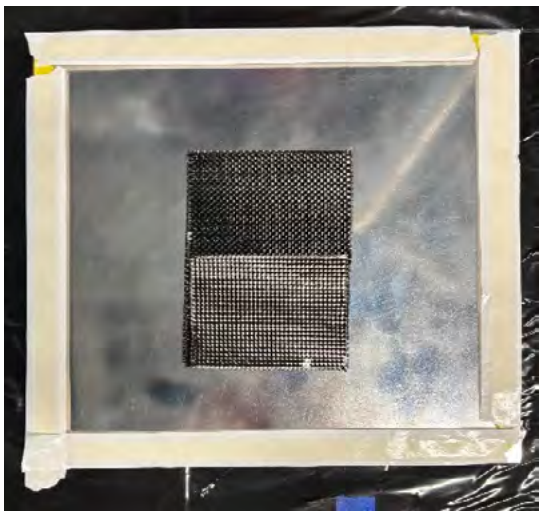

Figure 1: 15 Layer carbon fiber part shown on tooling with the horizontal ply-drop of lamina 4

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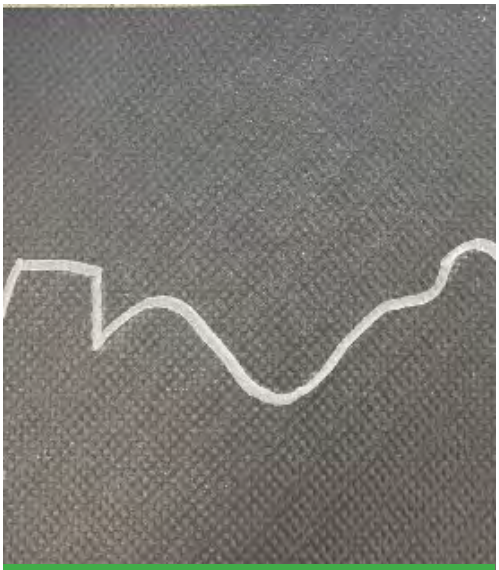

Figure 2: 9 layer carbon fiber part as shown with a uniquely shaped ply-drop

Unlike the 15 lamina composite which has a straight edge for the ply drop, the 9 lamina composite is manufactured with an irregular edge, where the shape is not known by the inspector prior to scanning and analysis. This composite was manufactured as a 178 mm x 178 mm part and nominally trimmed on a wet bandsaw after manufacturing. The irregular edge is shown in Figure 2 where the silver sharpie line is used to highlight the edge of the trimming.

Ultrasound Testing

The ultrasound testing was performed in an immersion tank with the Olympus Focus PX for data collection shown in Figure 3a. A 10 MHz spherically focused transducer with a 6.35 mm element size was used for the scanning in pulse-echo mode. The transducer was moved continuously from one side of the scan region to the other in a rastering pattern with step sizes of 0.2 mm in both dimensions. The two movements are termed the scan and index directions, shown in Figure 3b from a top-down perspective of the ultrasound tank. To ensure uniform focusing throughout the part, even as the thickness changes, the transducer was focused on the front wall. For the 15-layer part, a 50 mm x 70 mm scan area was completed to encompass most of the part, and included the ply-drop region. Similarly, an 80 mm x 80 mm scan area was used on the 9 layer part also encompassing the ply-drop region.

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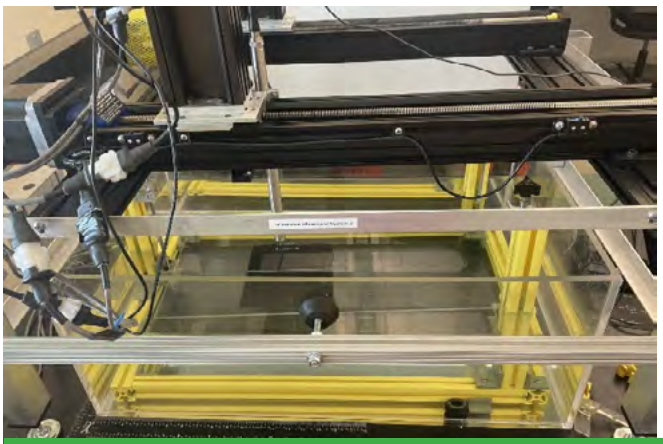

Figure 3: (a) Ultrasound immersion tank with carbon fiber part inside of it, (b) scan and index axes orientation from a top down view of the immersion tank

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Ultrasound Analysis

The analysis is performed two different ways, the first is a visualization of the captured acoustic waveforms providing a geometric interpretation, and the second is an automated surface tracking approach to extract the 3D shape of the individual lamina. Both results are discussed in the following section, and the results are in agreement with the expected behavior of the ply drop.

Visual waveform analysis

The analysis steps for the visual interpretation analysis approach are presented using results from the 15 lamina part, but the same steps hold true for the 9 lamina part. Every signal the transducer receives is recorded in the form of an amplitude, or A-Scan. The waveform of a representative A-Scan over the thick portion of the laminate is shown in Figure 4. The first peak of the waveform occurs from the reflection from the front wall, or where the part starts. The last major peak is the reflection corresponding to the back wall, or where the part ends. The peaks in between are the echoes from the soundwave contacting a change in material, specifically the interface between individual lamina.

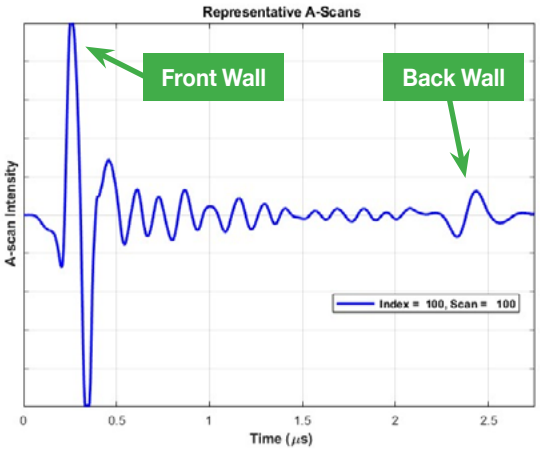

Figure 4: Representative A-Scan near the center of the scan region

There is a reflection wave at most interfaces between lamina due to the matrix/fiber interface providing a surface for the sound wave to reflect off.

B-Scans and D-Scans are two dimensional orthogonal slices of the reconstructed laminate formed by the received ultrasound signals. They are formed by lining up the A-scans side by side and plotting the intensity values along a colormap. The only difference between B-Scan and D-Scans is which direction, respectively, the scan or the index direction, of the part they look down. This is important for analyzing ply-drops, because depending on if the ply-drop is orthogonal or parallel to the axis being looked down for a given B- or D-Scan, the ply-drop may or may not be visible. In Figure 5, the presence of a ply-drop is visible on the D-Scan taken at $\chi_1 = 15$ mm because the back wall reflection occurring near 3.1 mm varies across the χ_2 coordinate whereas the front wall remains relatively constant at 0 mm. Conversely, the back wall reflection wave does not appear to change in depth for the B-Scan taken at $\chi_2 = 20$ mm.

Although the presence of the ply drop can be identified in the D-scan, neither the planar nor the interplanar location of the ply-drop can be readily determined by visual inspection of the B-Scan and the D-Scan. Note, if the ply-drop is not orthogonal to either χ_1 or χ_2 then it would be expected that the presence of a ply drop, based on the backwall reflection wave, would be visible in both scans, but the specific depth location would remain uncertain as in Figure 5. Thus, it is necessary to develop a method to track the layers in order to quantify which lamina is dropped.

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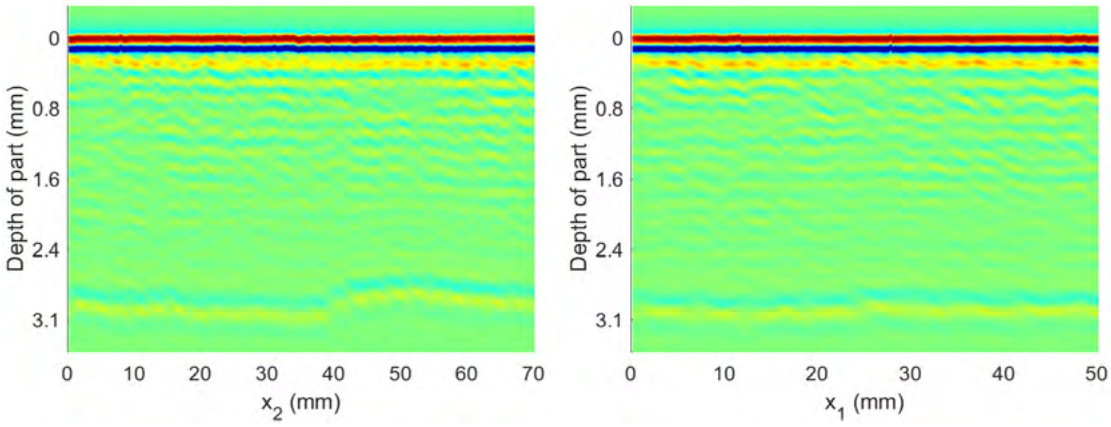

Figure 5: Representative D and B scans of 15 lamina composite showing the ply drop being observed in the D-scan. (a) D-Scan at χ_1=15 mm and (b) B-scan at χ_2=20 mm, which occurs in the 15 lamina region of the composite.

Automated Waveform Analysis and Layer Tracking

To track the location of the layers and consequently the ply-drop, a number of steps are taken sequentially. First, the A-scans are loaded from the proprietary *.fpd data format produced by the Olympus Focus PC software into a series of double precision arrays in the MATLAB environment. Trimming of the A-scans occurs during this step to remove unnecessary temporal data that was collected of the signal before the front wall reflection and after the back wall reflection. Next, Gaussian smoothing is applied to the A-scans to mitigate signal noise generated from the scanning system. Then the A-scans are shifted for the front wall to all align at the same point in time, forming a perfectly flat reconstruction of the part. This is done to remove any part curvature and also remove any misalignments during the scan setup.

To determine the planar location of the ply drop from the pre-processed data, the spatial location in (χ_1, χ_2) where the part thickness variations occur are identified. The thickness is measured via time of flight measurements with Equation 1, where d is the distance, i_{last} is the time step when the

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$$d(x_1, x_2) = \frac{i_{last}(x_1, x_2) - i_{first}(x_1, x_2)}{f} \times \frac{c}{2} \quad (1)$$

back wall is identified by the last rising wave in the acoustic signal, i_{first} is the time step when the front wall is identified by the first rising wave in the acoustic signal, f is the frequency of the digitizer, in this case 100 MHz, and c is the speed of sound of the carbon fiber composite, which is approximated to be 2,800 $\frac{m}{s}$ by a previous internal study where the presence of the factor of 1/2 in Equation (1) comes from the use of pulse-echo ultrasound. The plot of the raw thickness of the 15 laminate part is shown in Figure 6. There is variation in the plot due to the weave of the fabric and chatter in the physical scanning system and is smoothed in a subsequent step.

It can be observed from Figure 6 that there are two distinct regions of part thickness. Thresholding techniques were used to separate the two regions and binarize the results. Due to the weave effects, the thresholding does not perfectly encapsulate the two regions, and image processing segmentation techniques are used to complete the binarization process. Once the thickness of the part is segmented into two regions, the location of the drop is readily found, and a line of best fit with a 2nd order polynomial was applied to the location of the drop, as shown in Figure 7a for the 15 lamina part with a simple cut . Due to the unique shape of the ply-drop in the 9 lamina part shown in Figure 2, a 13th order polynomial was applied to the 9 lamina part. This is seen in Figure 7b where the ply drop is observed to closely match that of the trimmed region shown in Figure 2.

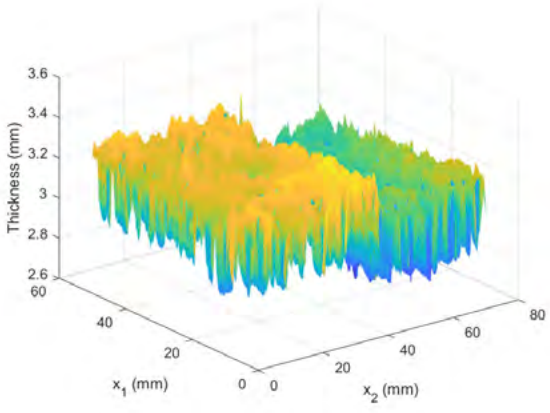

Figure 6: Thickness plot representing the thickness from each point of the scanned region

Following the identification of the planar location of the ply-drop, the interplanar location of the ply-drop can be determined. The number of lamina at each scan point can be determined by finding the peaks in the A-scan. However, interfaces other than the interlaminar interfaces can cause a peak. This could be porosity, a misplaced fiber, or extremely small foreign object debris that was introduced during manufacturing. As a result, individual A-scans may suggest a part with as few as 2 or 3 layers even though the point is surrounded by a constant 15 or 14 layers, or it might appear to have as many as 18 or 19 layers. By locally averaging the A-scans using square kernels covering 5 points in both χ_1 and χ_2, the peaks within a given averaged A-scan were observed to more likely correspond to the number of layers in the part. Figure 8 shows an example image of how the peaks correspond to the layers, within the thinner 14 lamina region of the 15 lamina composite.

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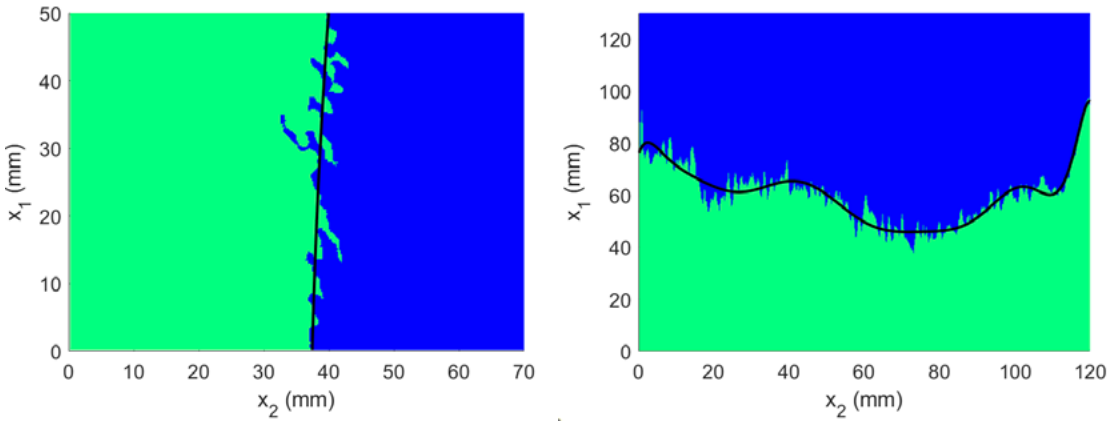

Figure 7: (a) planar location of ply-drop of 15 lamina part fitted to a 2nd order polynomial, planar location of ply-drop of 9 lamina part fitted to a 13th order polynomial

The peaks are next tracked in (χ_1, χ_2) across the matrix of averaged A-scans to represent where the layers are. Since both the front wall and the back wall are included in the peaks and all the interfaces, there is one more peak than the total number of lamina. At the ply-drop, the ultrasound waveform experiences a stronger reflection back to the transducer, most likely due to the resin rich wedge region at the ply-drop. The interlayer interface that initiates the front of the layer has scattering in the region of the ply-drop. Thresholding techniques are used to determine which layer scatters, and thus initiates the ply-drop. Figure 9 shows for the tracking of layer 3 that there is not an area of scattering around the ply-drop region. Conversely, Figure 10 shows a region of scattering around the ply-drop region in the tracked layer 4. Additional layers beyond layer 4 continue to show the scattering due to the waveform being altered at layer 4.

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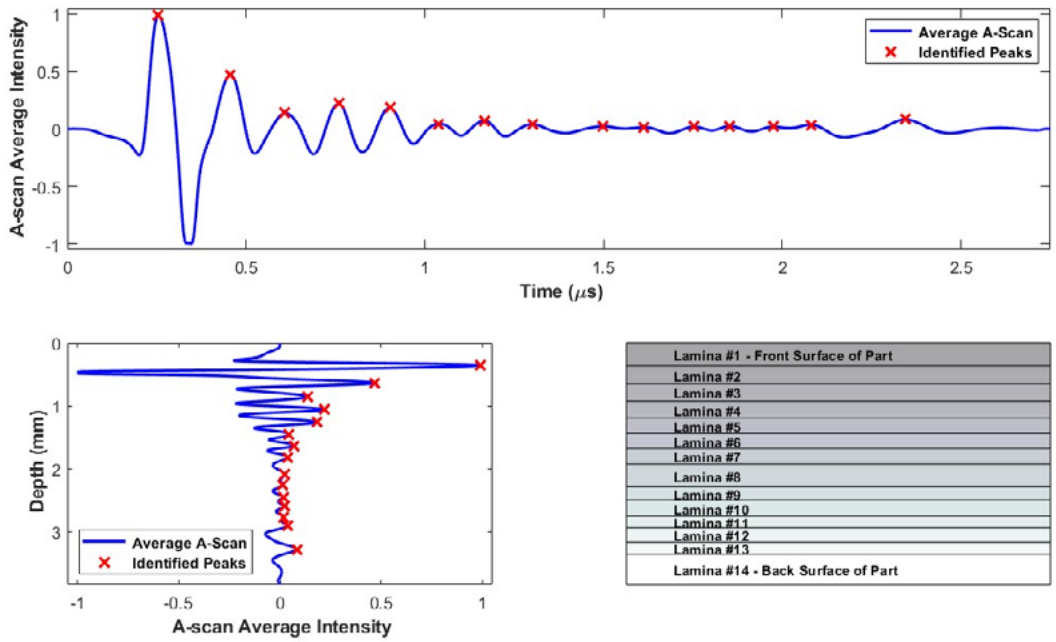

Figure 8: Relationship between A-Scan peaks and number of lamina

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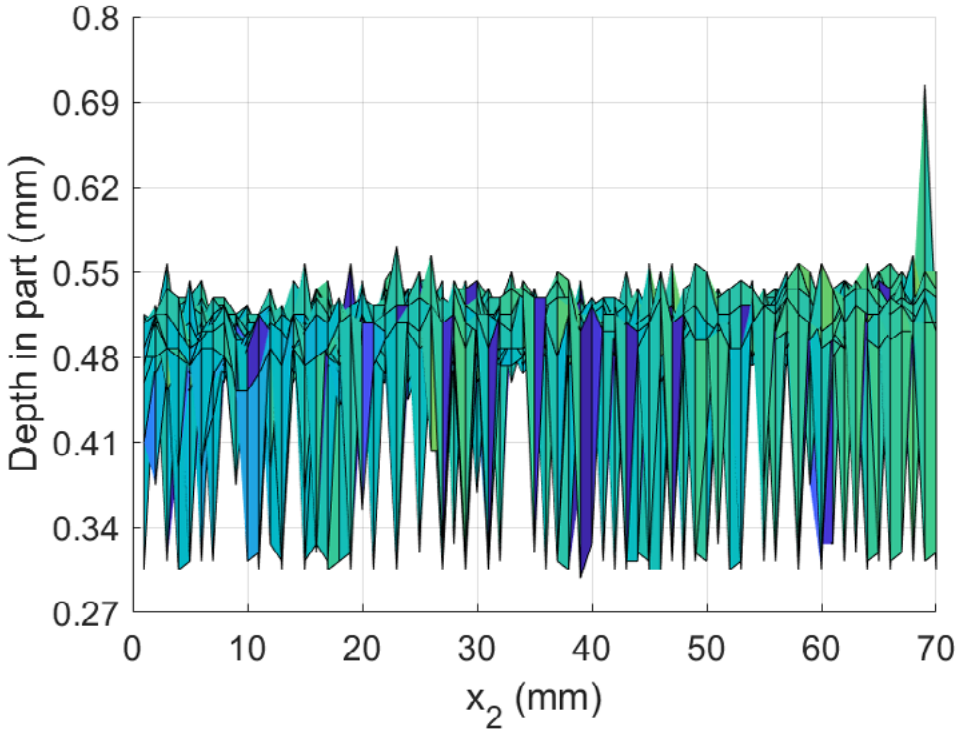

Figure 9: Layer 3 as tracked by the location of the peaks interlayer peaks

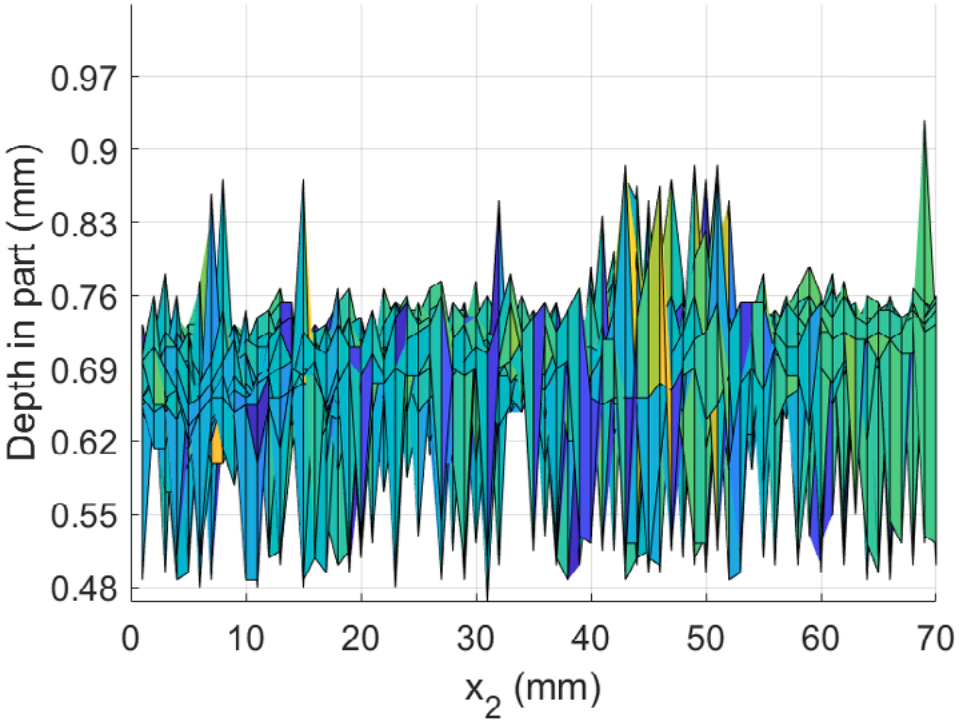

Figure 10: Scattering seen in layer 4 amongst the location of the peaks in the ply-drop region

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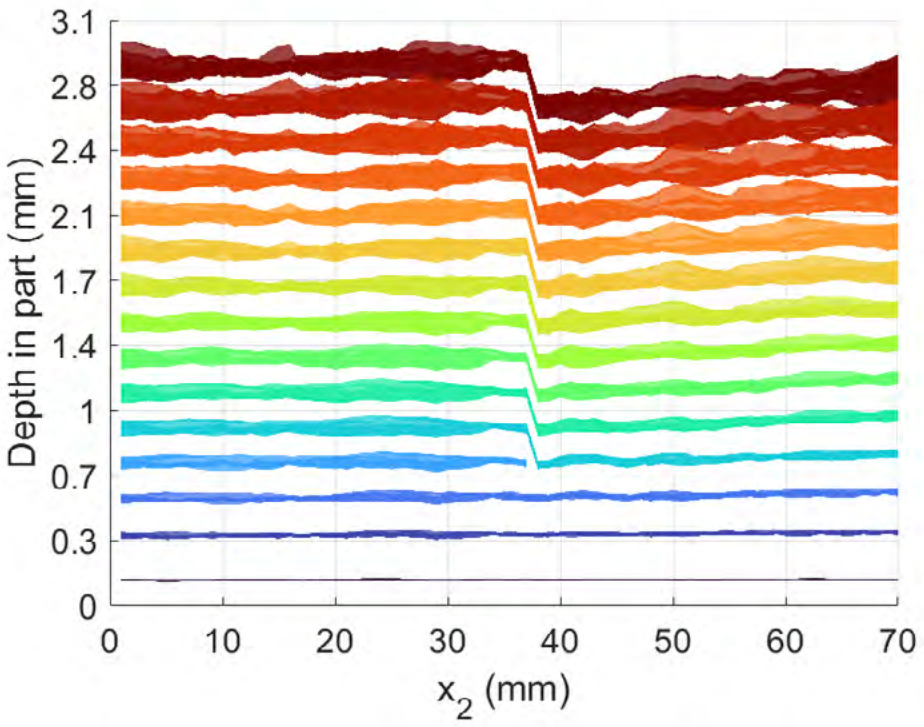

Figure 11: 3D plot of the layers in the part, the bottom layer is layer 1 and the top layer is layer 15

The algorithm does not solely check for the presence of scattering in a layer, because scattering could occur due to a defect in the part and might not be in the region of the ply-drop. The algorithm checks that the scattering occurs in the region around the planar location of the ply-drop. Once the algorithm determines that the scattering occurs in the ply-drop region, it identifies the first layer with the scattering as the dropped layer. Based on this information, a 3D plot is developed showing the χ_3 location of the individual lamina as a function of (χ_1, χ_2) from which the ply drop can be easily visualized, as shown in Figure 11. The surface map of the ply drop is smoothed for visualization purposes. From the 3D visualization, the comprehensive information about the shape and location of a ply-drop can be quantified.

Conclusion and Future Work

Ply-drops are an integral component to designing carbon fiber parts for many different applications. Due to ply-drops changing the mechanical characteristics of the carbon fiber composite, it is important to know where ply-drops occur. In this paper a pulse-echo ultrasound method is developed to inspect carbon fiber composites when only one side of the part is accessible for inspection. To find the planar location of the ply-drop, thresholding and image processing techniques were presented to characterize the part into distinct thickness regions.

To find the interplanar location of the ply-drop, the peaks that define the layer-to-layer interfaces in an ultrasound A-scan are extracted, and the locations of the

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layer-to-layer interfaces with respect to the front wall were used to construct representations of the layer interfaces. By thresholding these layer interfaces and determining where scattering starts, then the interplanar location of the ply-drop as well as the ply geometry can be determined.

Future work includes creating an algorithm that detects multiple ply-drops in parts. Emphasis will be placed on both multilayer ply-drops that all occur at the same planar location and on single layer ply-drops that occur at different planar locations along the part.

Acknowledgements

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Bibliography

[1] Ahmad, H., Markina, A. A., Porotnikov, M. V., and Ahmad, F., 2020, "A Review of Carbon Fiber Materials in Automotive Industry," IOP Conf. Ser. Mater. Sci. Eng., 971(3), p. 032011. https://doi.org/10.1088/1757-899X/971/3/032011.

[2] Yang, J., Song, B., Zhong, X., and Jin, P., 2016, "Optimal Design of Blended Composite Laminate Structures Using Ply Drop Sequence," Compos. Struct., 135, pp. 30–37. https://doi.org/10.1016/j.compstruct.2015.08.101.

[3] Dhurvey, P., and Mittal, N. D., 2013, "REVIEW ON VARIOUS STUDIES OF COMPOSITE LAMINATES WITH PLY DROP-OFF," SSN, 8(8).

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This Issue:

ACCE Award Winning Paper continued...

[4] Lu, X., Higuchi, R., Hua, X., Nagashima, T., and Yokozeki, T., 2024, "Experimental and Numerical Study on Failure Mechanisms of Tapered Laminates: Effects of Ply Thickness and Taper Ratio," Compos. Sci. Technol., 256, p. 110784. https://doi.org/10.1016/j.compscitech.2024.110784.

[5] Thawre, M. M., Verma, K. K., Jagannathan, N., Peshwe, D. R., Paretkar, R. K., and Manjunatha, C. M., 2016, "Effect of Ply-Drop on Fatigue Life of a Carbon Fiber Composite under a Fighter Aircraft Spectrum Load Sequence," Compos. Part B Eng., 86, pp. 120–125. https://doi.org/10.1016/j.compositesb.2015.10.002.

[6] Vidyashankar, B. R., and Krishna Murty, A. V., 2001, "Analysis of Laminates with Ply Drops," Compos. Sci. Technol., 61(5), pp. 749–758. https://doi.org/10.1016/S0266-3538(01)00010-0.

[7] Séguin-Charbonneau, L., Walter, J., Théroux, L.-D., Scheed, L., Beausoleil, A., and Masson, B., 2021, "Automated Defect Detection for Ultrasonic Inspection of CFRP Aircraft Components," NDT E Int., 122, p. 102478. https://doi.org/10.1016/j.ndteint.2021.102478.

[8] Jolly, M., Prabhakar, A., Sturzu, B., Hollstein, K., Singh, R., Thomas, S., Foote, P., and Shaw, A., 2015, "Review of Non-Destructive Testing (NDT) Techniques and Their Applicability to Thick Walled Composites," Procedia CIRP, 38, pp. 129–136. https://doi.org/10.1016/j.procir.2015.07.043.

[9] Wang, B., Zhong, S., Lee, T.-L., Fancey, K. S., and Mi, J., 2020, "Non-Destructive Testing and Evaluation of Composite Materials/Structures: A State-of-the-Art Review," Adv. Mech. Eng., 12(4), p. 1687814020913761. https://doi.org/10.1177/1687814020913761.

[10] Hasiotis, T., Badogiannis, E., and Tsouvalis, N. G., 2011, "Application of Ultrasonic C-Scan Techniques for Tracing Defects in Laminated Composite Materials," Stroj. Vestn. – J. Mech. Eng., 2011(03), pp. 192–203. https://doi.org/10.5545/sv-jme.2010.170.

[11] Chandraa, N., Van Lear, R., Yudhanto, A., Zhao, Y., Jack, D. A., and Smith, D. E., "Characterizing Intralaminar Distal Crack and Delamination in Multidirectional Laminates Under Low Velocity Impact: Modeling Approach With Ultrasound Testing Validation," Polym. Compos., n/a(n/a). https://doi.org/10.1002/pc.30136.

[12] Nargis, R. A., Pulipati, D. P., and Jack, D. A., 2024, "Automated Foreign Object Detection for Carbon Fiber Laminates Using High-Resolution Ultrasound Testing," Materials, 17(10), p. 2381. https://doi.org/10.3390/ma17102381.

[13] Smith, R. A., Nelson, L. J., Mienczakowski, M. J., and Wilcox, P. D., 2016, "Ultrasonic Tracking of Ply Drops in Composite Laminates," AIP Conf. Proc., 1706(1), p. 050006. https://doi.org/10.1063/1.4940505.

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