Automated Macro-scale Damage Characterization of Plain-Weave S-2 Glass/Epoxy Composite Laminates

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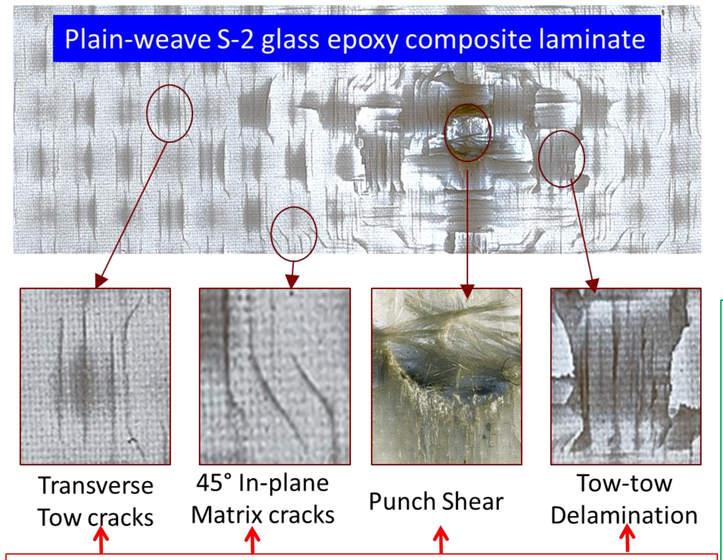
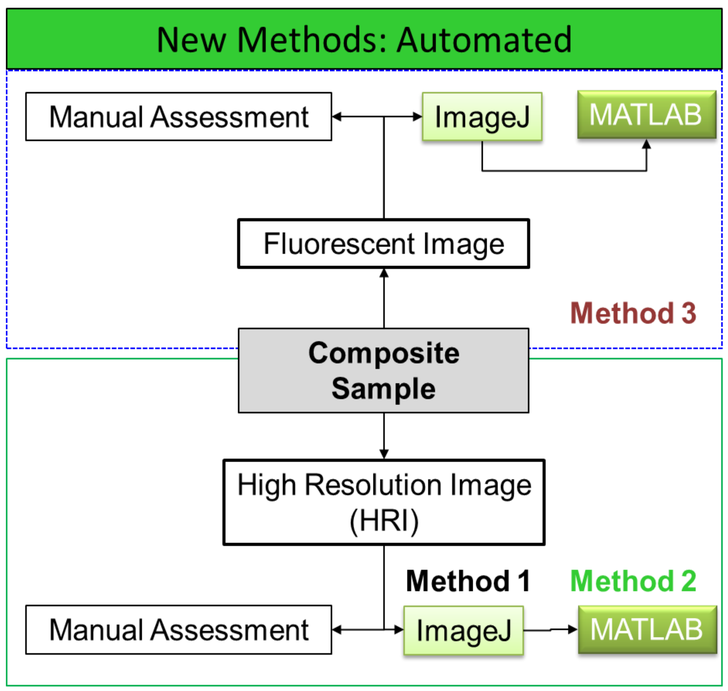
Enterprise for Multi-scale Research of Materials

How We Fit



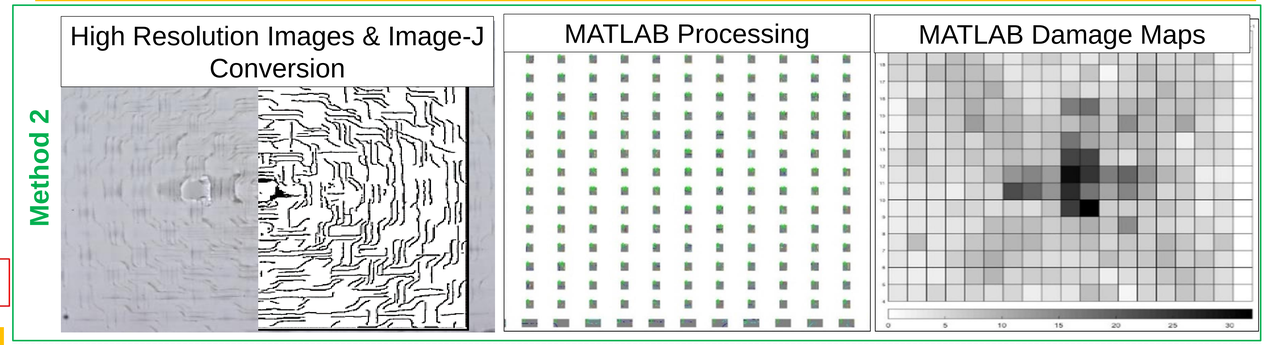
Technical Approach

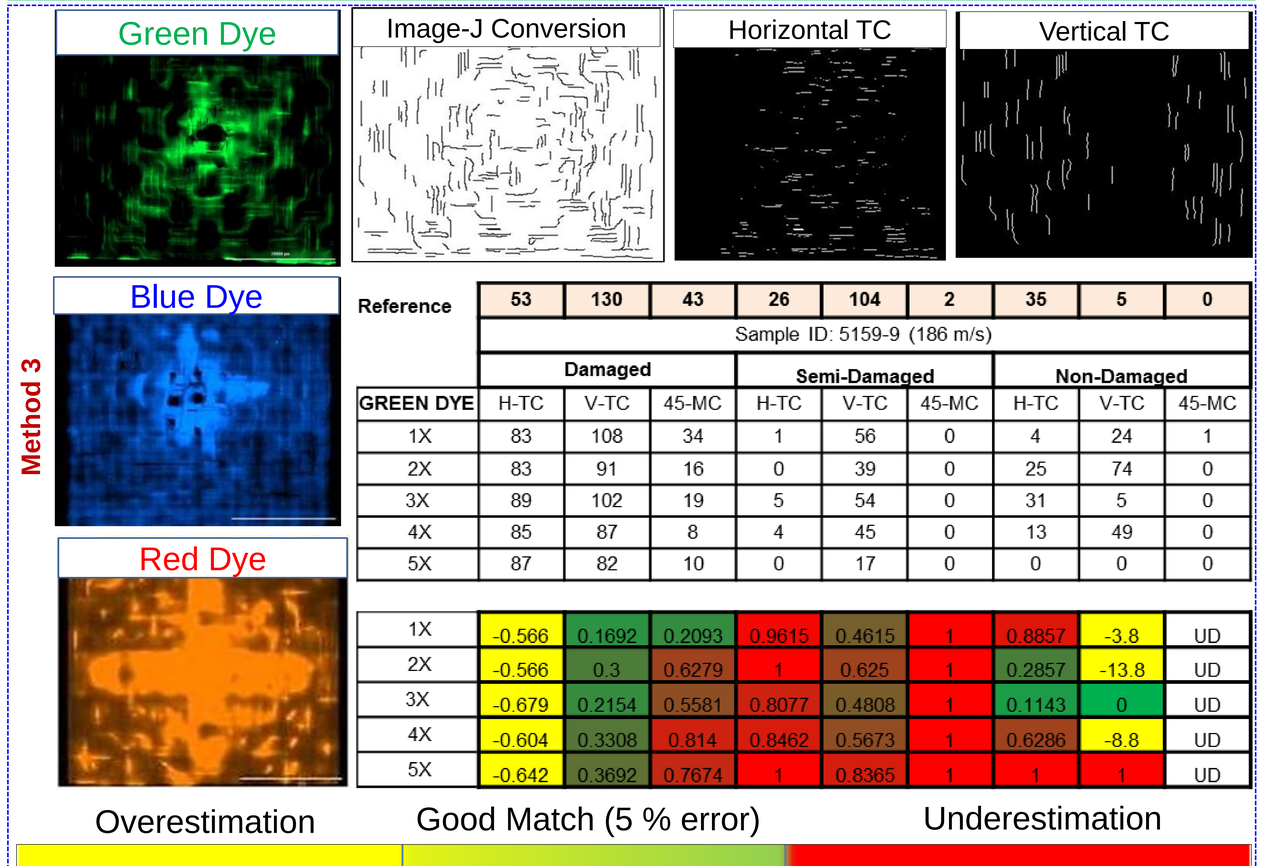


Goals and Motivation

1. **To develop an algorithm to automatically trace and quantify the amount of damage on composite materials.**
2. **Demonstrate proof-of-principle use of fluorophores in the assessment and quantification of damage in composite materials.**
3. **Compare the damage profiles generated by Image-J (Java) tracing and automated MATLAB-processing.**

Major Results





Reference	53	130	43	26	104	2	35	5	0
	Sample ID: 5159-9 (186 m/s)								
	Damaged			Semi-Damaged			Non-Damaged		
GREEN DYE	H-TC	V-TC	45-MC	H-TC	V-TC	45-MC	H-TC	V-TC	45-MC
1X	83	108	34	1	56	0	4	24	1
2X	83	91	16	0	39	0	25	74	0
3X	89	102	19	5	54	0	31	5	0
4X	85	87	8	4	45	0	13	49	0
5X	87	82	10	0	17	0	0	0	0

1X	-0.566	0.1692	0.2093	0.9615	0.4615	1	0.8857	-3.8	UD
2X	-0.566	0.3	0.6279	1	0.625	1	0.2857	-13.8	UD
3X	-0.679	0.2154	0.5581	0.8077	0.4808	1	0.1143	0	UD
4X	-0.604	0.3308	0.814	0.8462	0.5673	1	0.6286	-8.8	UD
5X	-0.642	0.3692	0.7674	1	0.8365	1	1	1	UD

Overestimation — Good Match (5 % error) — Underestimation

Key Accomplishments

- Used ImageJ to provide quantitative measure of all damage modes without spatial resolution.
- Developed a MATLAB algorithm that can quantify all damage with spatial resolution.
- Preliminary results show that Green dye provides close estimates for transverse cracks compared to red and blue dyes.

Future Directions

1) Use hand-held devices (e.g. smartphones) equipped with software for automated damage assessment and quantification.
2) Introduce artificial intelligence (AI) tenet in to the algorithm to discriminate accurately the damage types.
3) To optimize the algorithm through evaluation of many samples (laminates).

Impact

1) Provide an on-site mechanism to automatically assess and quantify damage on materials.
2) Inform on the material tenacity for potential application in army protection, esp., vehicular.

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