

SMF Flyg 2015: STEP

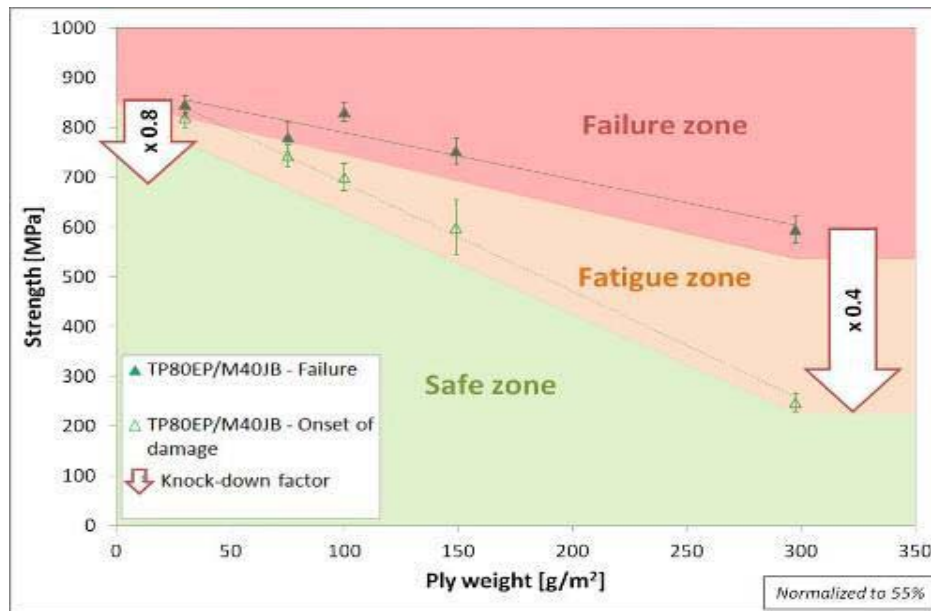
- STEP is a new manufacturing concept
- Oxeon patent pending
- One-STEP manufactured U-beams have been made

SMF Flyg 2015: STEP

- Constituent materials are aircraft qualified
- Use of standard robots from the automotive industry
- Less debulking
- Improved degassing
- Partly tested at Compraser Generation 1 robot line in Linköping
- Cycle time for each robotized step reduced by a factor of 4-10
- Generation 2 and 3 of Compraser robot line in Linköping is in progress

Thin-Ply Materials, a Micrometer Technology

- SICOMP probably has the research lead in Europe regarding thin-ply materials. A whole range of material- and manufacturing technologies have been studied together with Oxeon since 2004
- Perhaps the largest increase in material performance since carbon fiber was introduced. 50-100 % higher dimensioned strain



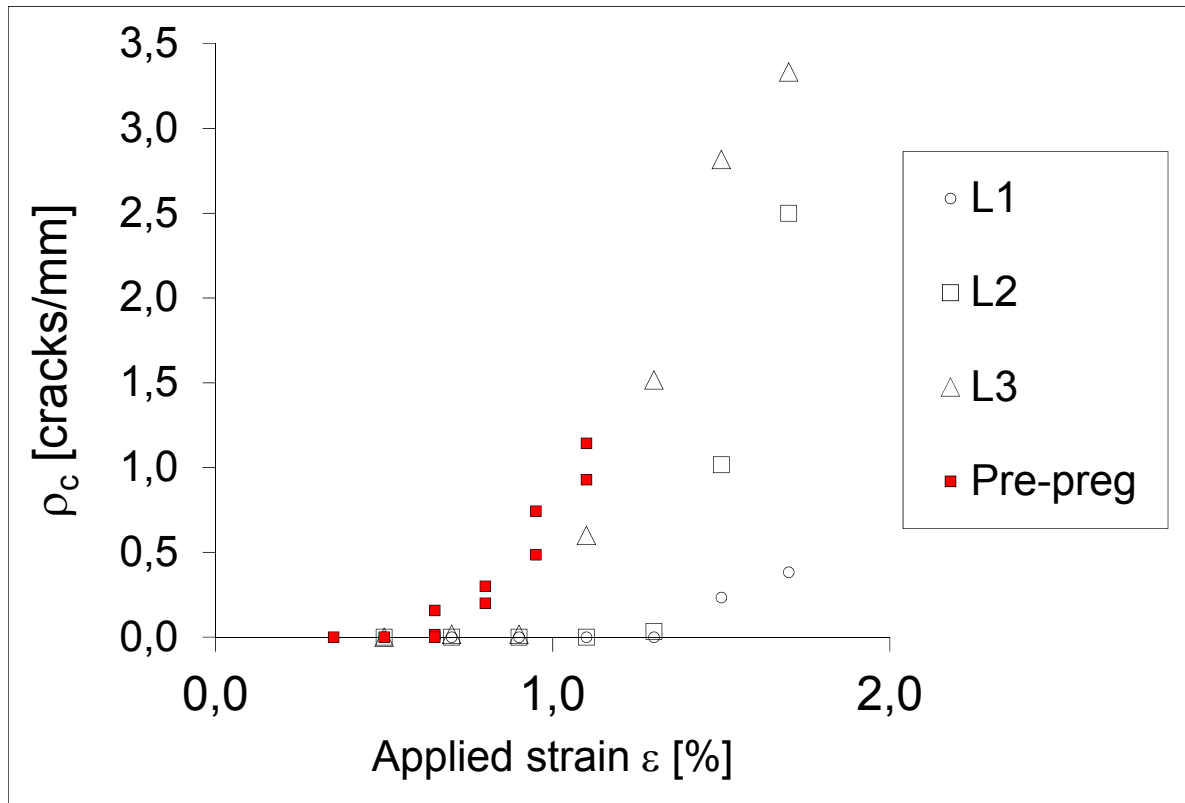
Experimental investigation of damage formation in thin-ply composites

SMF Flyg 2015

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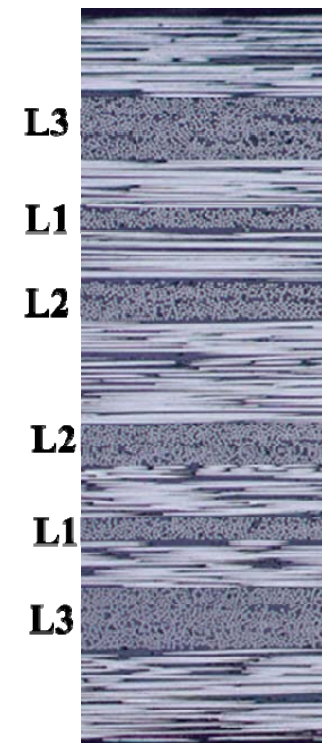
Crack density at -50°C

Plate A $[0_4/90_3/0_2/90/0_2/90_2/0_2]_s$



Layer thickness

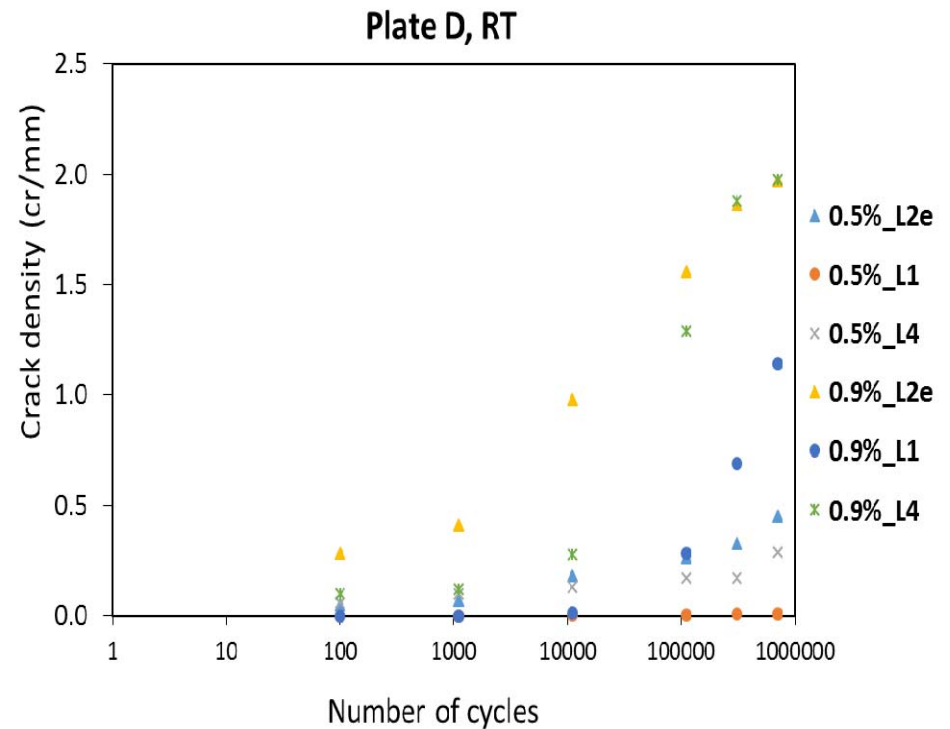
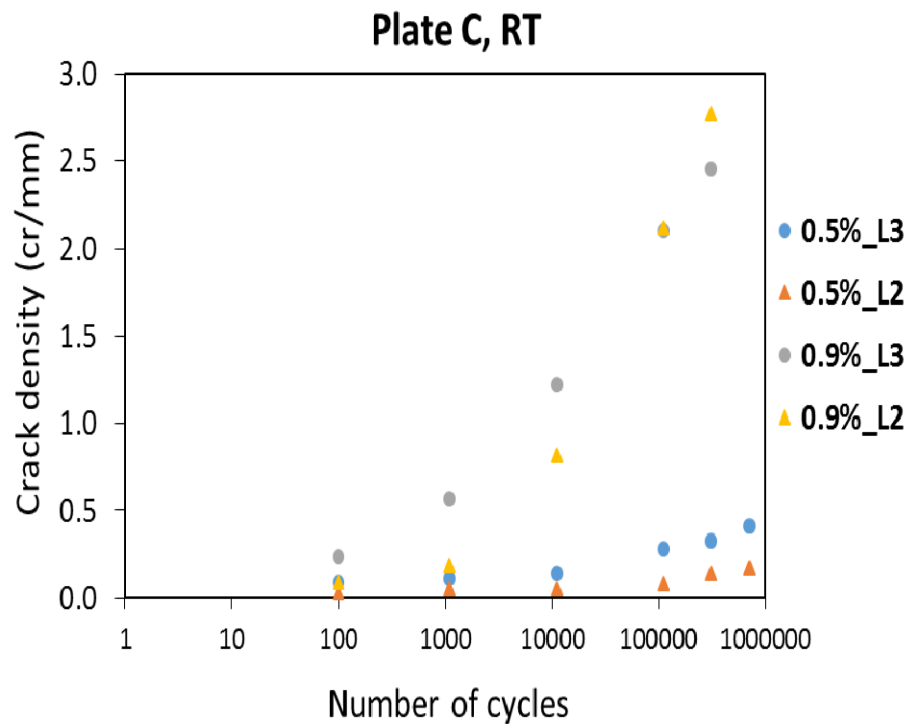
Pre-preg $\approx 300 \mu\text{m}$



Strain rate 1% per minute, applied mechanical strain levels from 0.5% to 1.7%

- The formation of micro-cracks is significantly delayed in the thinnest layers.

Fatigue tests: Results at RT

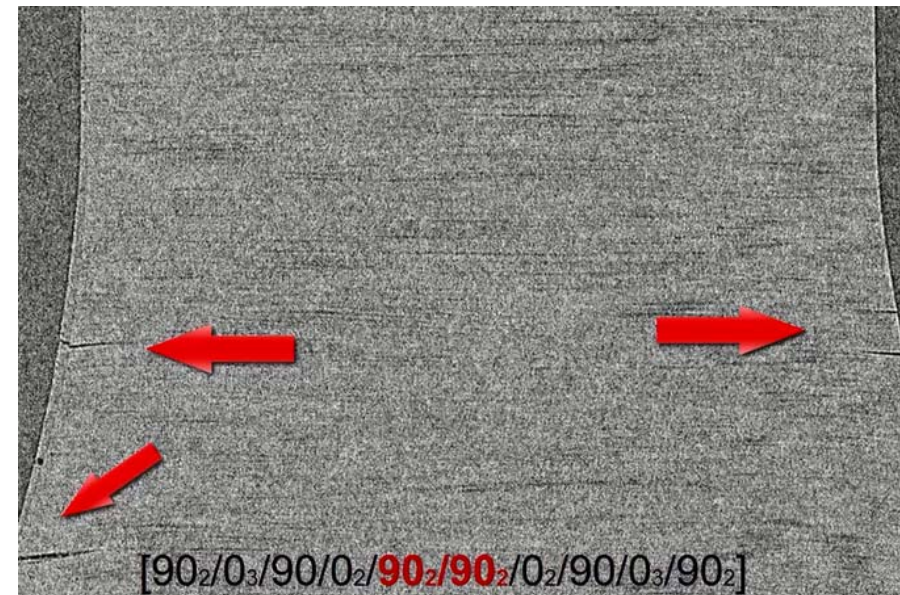
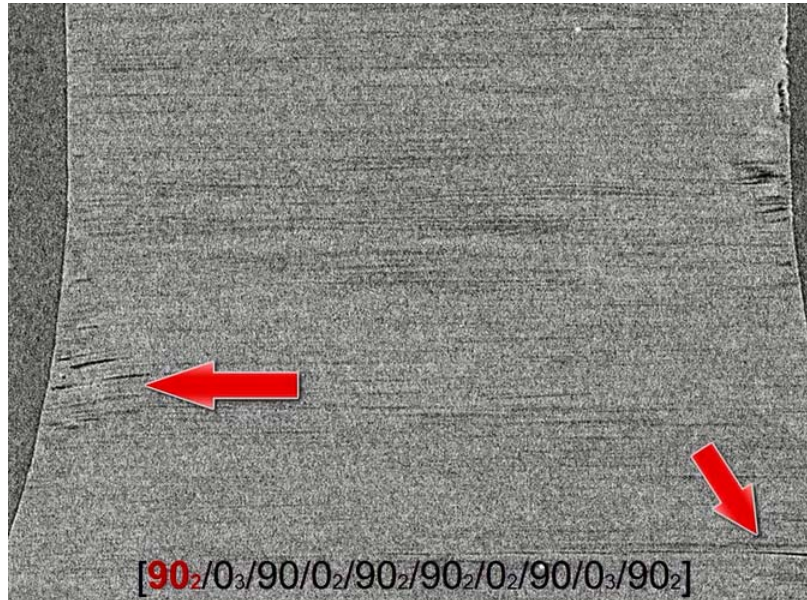


- Both layers, L2 and L3, have similar crack densities

- The internal thin layer L1 has less cracks than L2 and L4 in both cases

Results from Tomography

Plate A = $[90_2/0_3/90/0_2/90_2]_s$



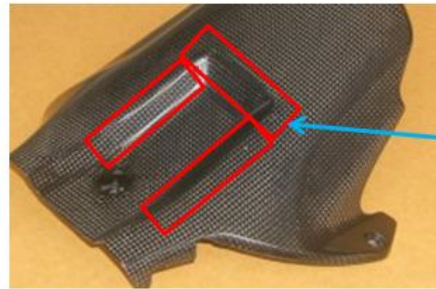
- Microcracks started to appear at 0.7% of applied strain (1500N)
- The thinnest layers do not contain cracks

Conclusions

- The results contributed to SICOMP manufacture of a tube demonstrator in the EU CHATT project
- The demonstrator was liner-less. TeXtreme was used as a liner. It was cooled down to $-196\text{ }^{\circ}\text{C}$ and subjected to an axial load which pulled 1.6 % axial strain. No Helium gas leakage was detected
- SICOMP estimated the weight gain for a cryogenic space tank to 20-30 % reduction in structural weight
- NASA full-scale tested a large tank in 2014, using a thin-ply material concept. NASA has claimed a huge technical breakthrough, with 30 % weight reduction

SICOMP Material Concept, LPC:

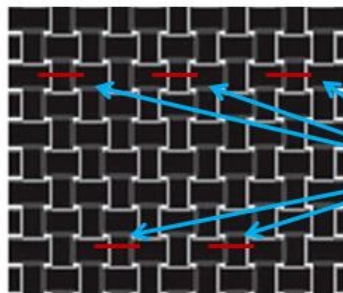
Local Point Cutting (LPC)



Cutting Area



Layers in Cutting Area



Cutting Pattern

SMF Flyg 2016: μ LPC

- μ LPC is Generation 2 of LPC
- Enables a reduction in the number of weave types, weave parts (loaded into the tool), waste, scrap and cycle time for some manufacturing routes
- Of particular interest for complex geometry aircraft parts, satellites etc.

Swerea SICOMP Manufacturing Concepts

- **LPC** – Local Point Cutting
- **μLPC** – micro Local Point Cutting
- **TailCast** – Tailored Reinforcement for Epoxy Casting
- **Re-Fib** – Recycling of Fibers using Thermal Treatment
- **HOST** – Holes, momentary or stationary, in spread tow weave to facilitate impregnation
- **STEP** – Spread Tow as Enabler for Processability
- **SeqPre** – Sequential Preforming
- **ToDegass** – Two Step Degassing
- **FiPMa** – Filter Particles During Manufacturing