STRUCTURAL HEALTH MONITORING USING CARBON NANOTUBE NETWORKS AND TIME DOMAIN REFLECTOMETRY (TDR)

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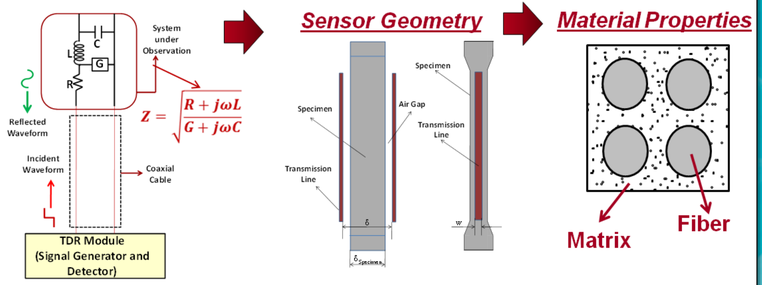
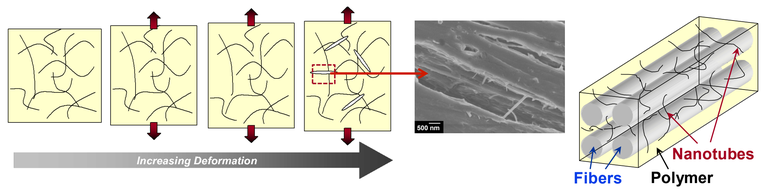
TIME DOMAIN REFLECTOMETRY (TDR) SENSING APPROACH



- TDR sensor output depends on sensor geometry and material properties. Impedance, $Z=f(\delta,w,\varepsilon,\mu)$
- Nanoscale reinforcements provide coupled electromagnetic-mechanical properties and can be used for sensing applications

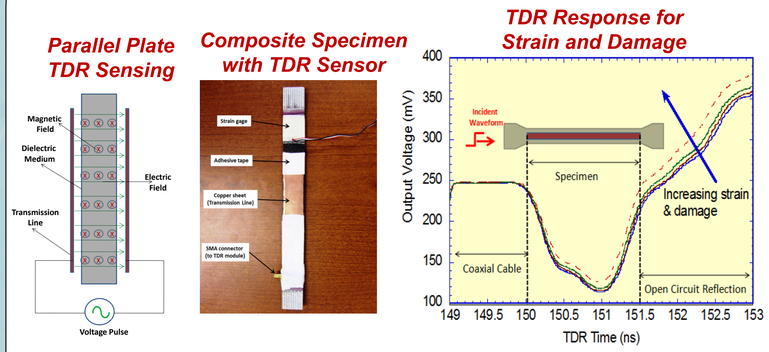
BACKGROUND: DC-BASED *IN SITU* SENSING WITH CARBON NANOTUBES



- DC Based Sensing: 3-D percolating nanotube networks formed in the matrix which are sensitive to onset and accumulation of cracks.
- TDR based sensing: Location specific damage information. Multiple sensors can be replaced with a single TDR sensor.

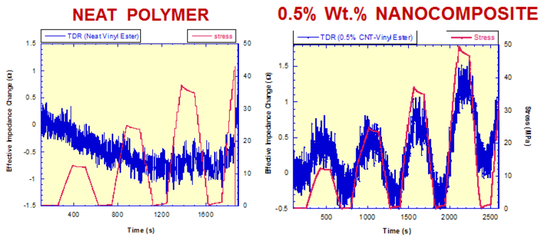
***Thostenson and Chou**, Advanced Materials **(2006)**,*
Thostenson and Chou,** Nanotechnology **(2008)
Gao, Thostenson and Chou,** Adv. Functional Mats. **(2009)

APPROACH : NON-INVASIVE PARALLEL PLATE TRANSMISSION LINES



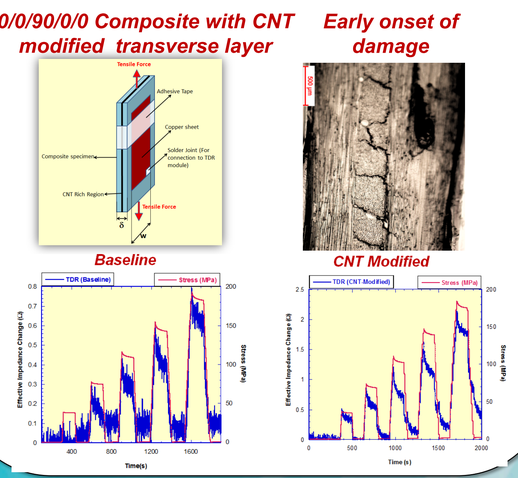
- Uniform penetration of electric and magnetic fields: can detect subsurface damage.
- Non invasive, unlike embedded sensors which themselves act as stress concentrations.
- Can be applied to existing structures.

INFLUENCE OF CNT ON STRAIN/TDR RESPONSE

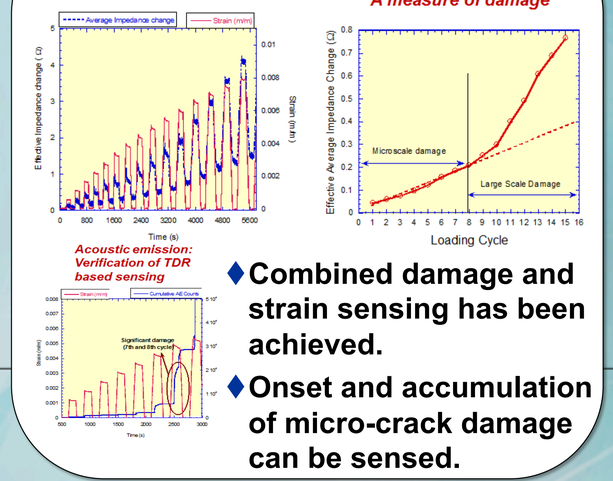


- Neat Vinyl Ester does not show TDR response.
- 0.5 wt. % CNTs impart self-sensing capability.

SELECTIVELY MODIFIED MULTIFUNCTIONAL COMPOSITES

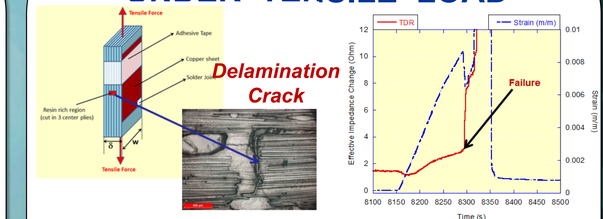


SENSING RESPONSE



- Combined damage and strain sensing has been achieved.
- Onset and accumulation of micro-crack damage can be sensed.

SENSING DELAMINATION UNDER TENSILE LOAD



- Sudden impedance increase can be observed near delamination in a 7 layer unidirectional composite.

ACKNOWLEDGEMENTS

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