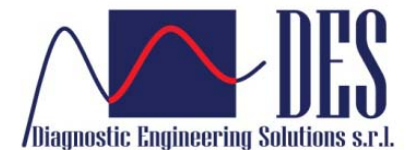


Controlli non distruttivi su materiali compositi



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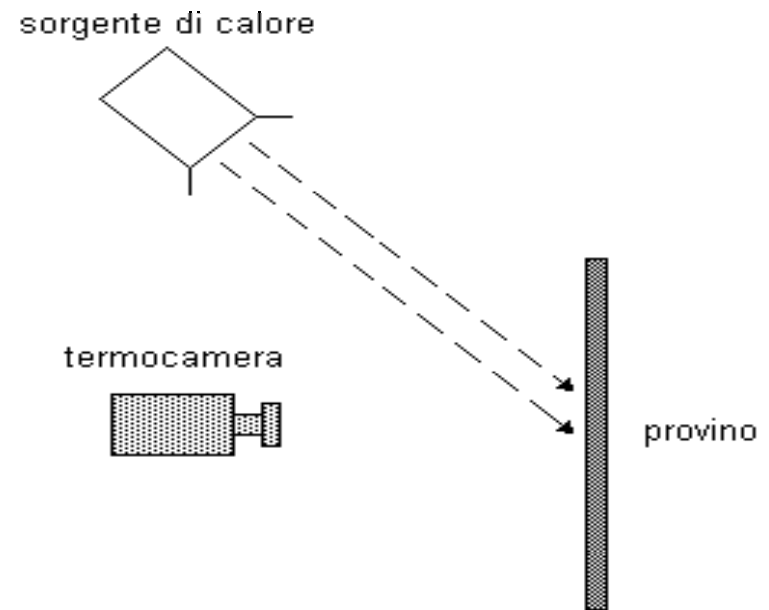
TERMOGRAFIA

Le tecniche termografiche per i controlli non distruttivi (NDT) sono basate sulla misura di anomalie termiche causate da:

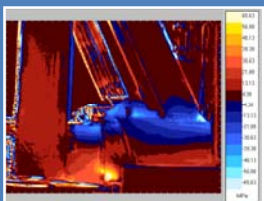
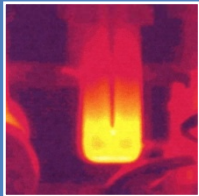
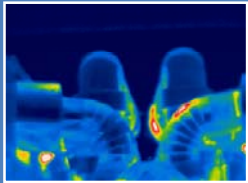
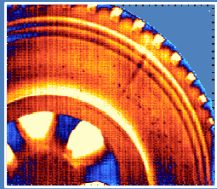
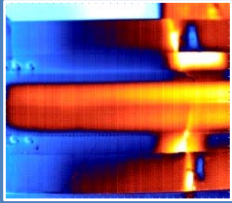
- presenza di difetti all'interno del provino
- variazioni delle proprietà del materiale che rappresentano un ostacolo alla normale diffusione termica.

Principali Vantaggi :

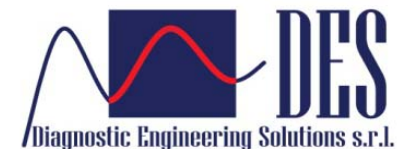
- 1) non richiedono contatto fisico
- 2) ispezionano ampie superfici
- 3) facilità di diagnosi



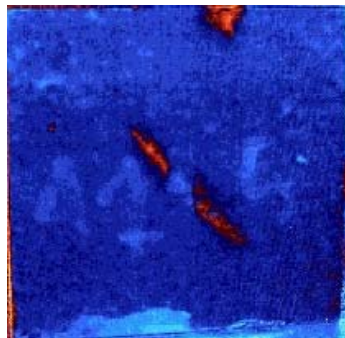
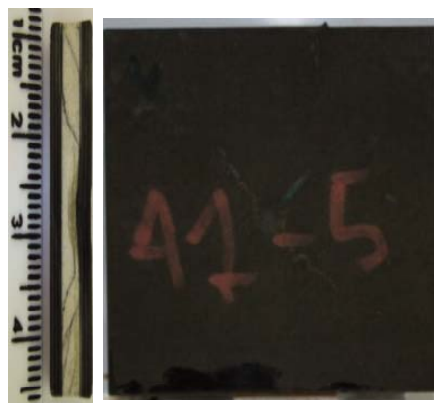
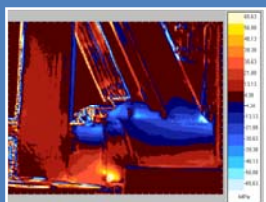
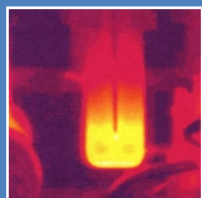
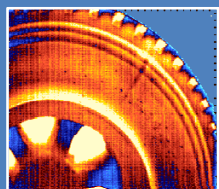
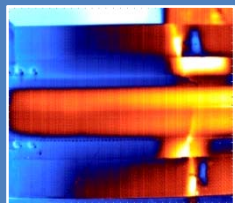
Esempio di termografia stimolata



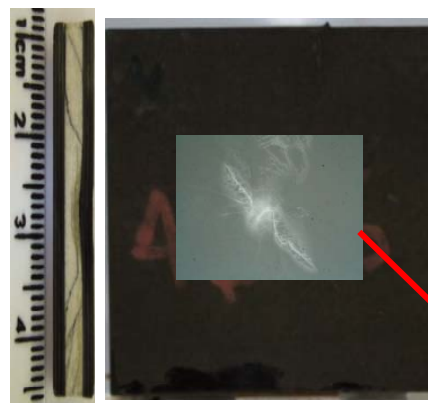
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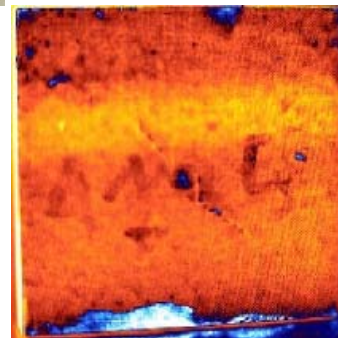
TECNICHE TERMOGRAFICHE



Termografia Pulsata



Radiografia
della parte
centrale del
provino

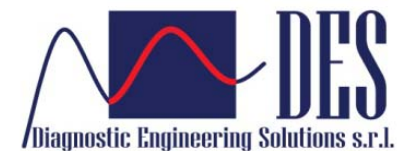


Termografia Lock-in

Confronto nella valutazione dei difetti fra le tecniche termografiche Pulsata e Lock-in e la tecnica radiografica su provino in fibra di carbonio, danneggiato mediante impatto.

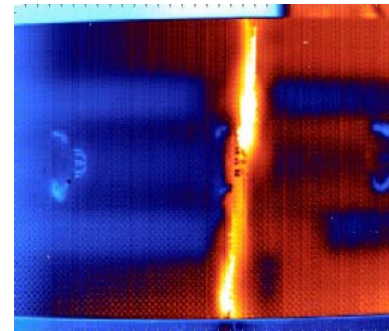
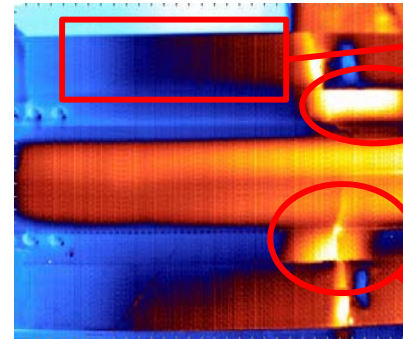
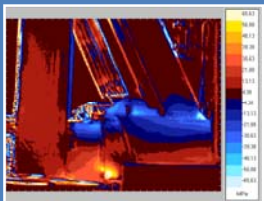
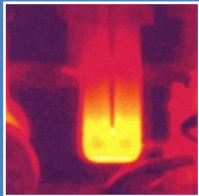
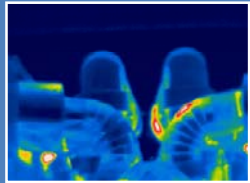
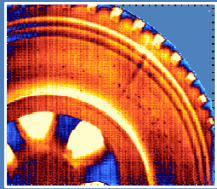
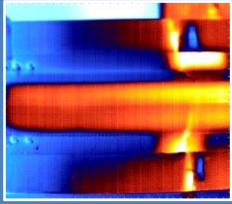


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TERMOGRAFIA LOCK-IN

Tecnica Lock-in: valutazione di difetti, variazioni di spessore e mancanza di incollaggio in materiali compositi



Variazione
spessore

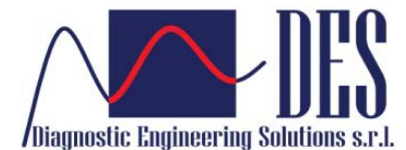
Mancanza
incollaggio

Difetto

**Analisi su stringer
aeronautico**

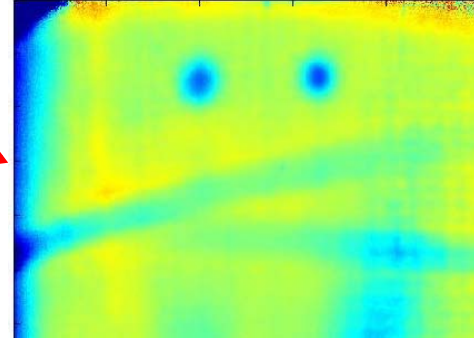
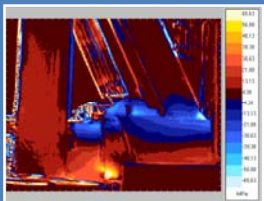
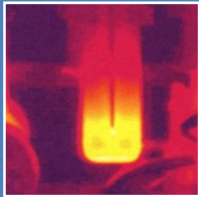
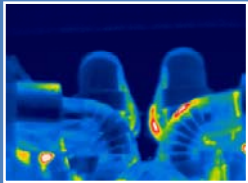
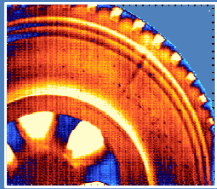
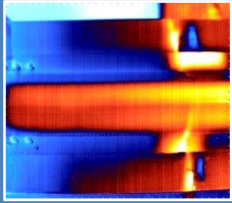


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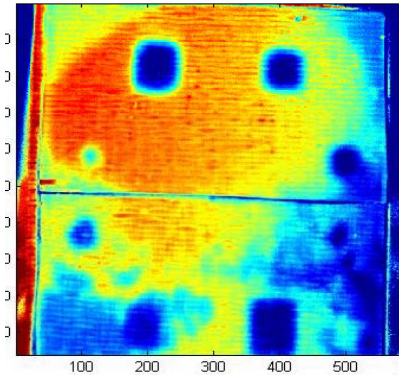
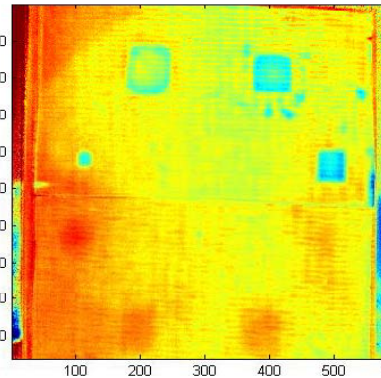


TERMOGRAFIA LOCK-IN

Tecnica Lock-in: valutazione di difetti in materiali compositi



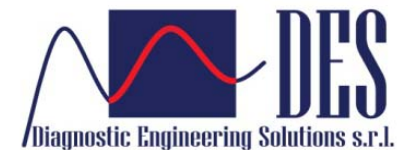
Radice di pala di un generatore eolico con difetti interni simulati.



Provino in composito GFRP con difetti interni simulati. I termogrammi sono relativi a due profondità di ispezione diverse.



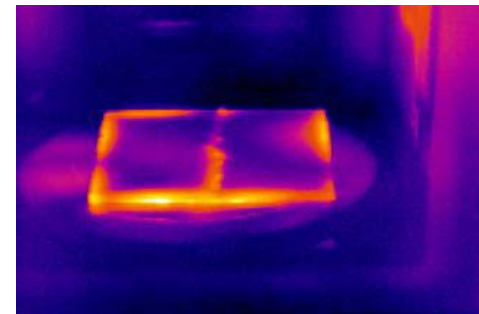
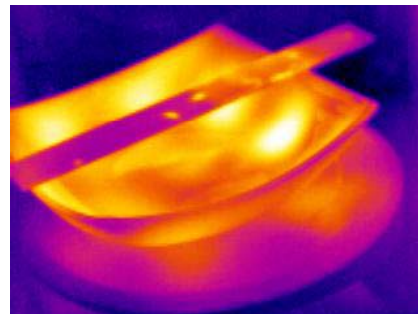
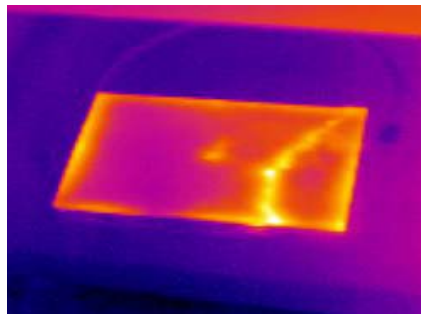
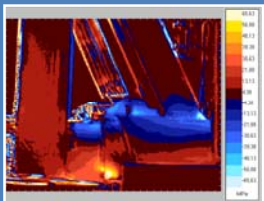
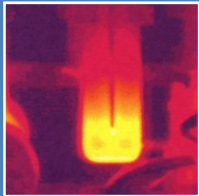
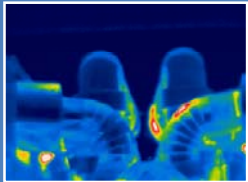
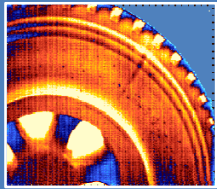
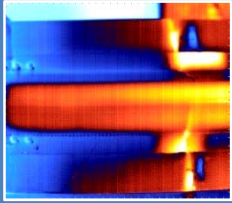
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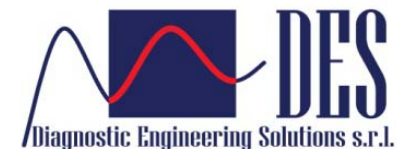
TERMOGRAFIA E MICROONDE

Le microonde possono essere utilizzate come sorgente di calore.

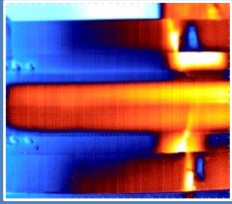
Le microonde non vengono utilizzate per riscaldare direttamente il materiale, ma l'acqua contenuta al suo interno. Per tale ragione, i difetti di piccole dimensioni dovuti a danni da impatto che hanno assorbito maggiore quantità di acqua, sono facilmente rilevabili e in tempi molto brevi, rispetto alle tecniche termografiche tradizionali.



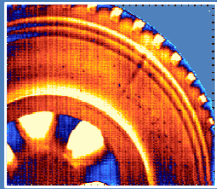
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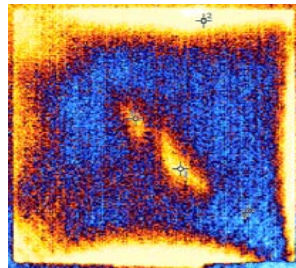
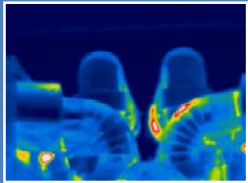
TERMOGRAFIA E MICRONDE



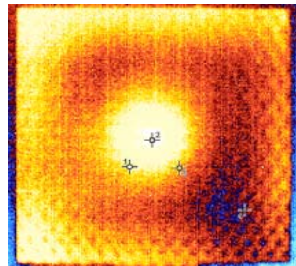
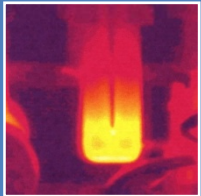
Questo tipo di riscaldamento garantisce brevi tempi di eccitazione del materiale e osservazione in profondità.



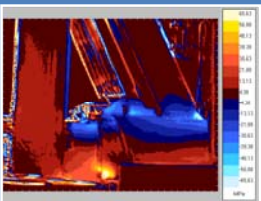
Risultati relativi a prove di termografia con sorgente a microonde su provino in fibre di carbonio:



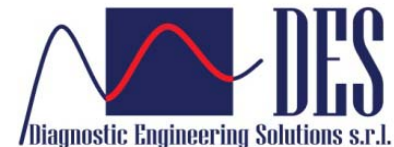
Frattura delle fibre di carbonio dello strato superficiale, dovute all'impatto nella zona centrale, che si estendono lungo le fibre ed effetto di bordo.



Effetto del calore prodotto da difetti subsuperficiali (**delaminazione**) causati da un impatto, ad una profondità di circa 5 mm dalla superficie.



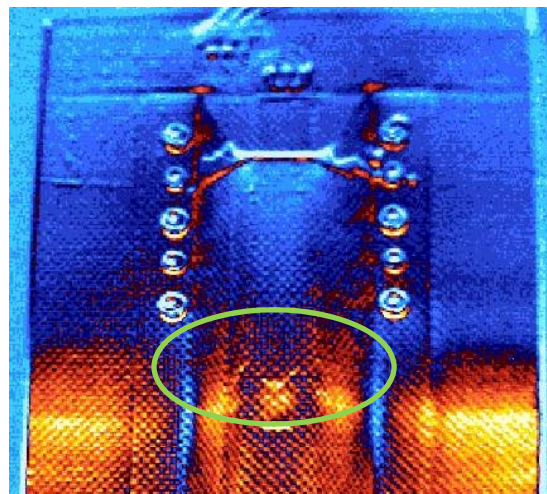
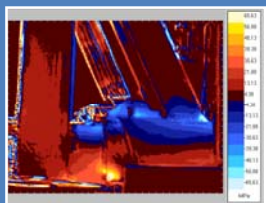
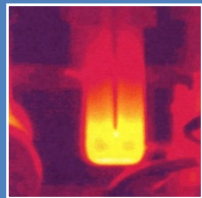
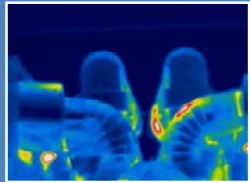
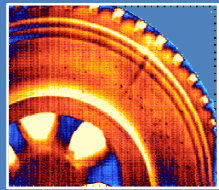
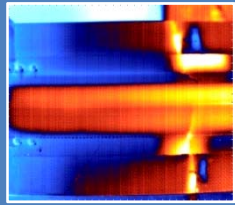
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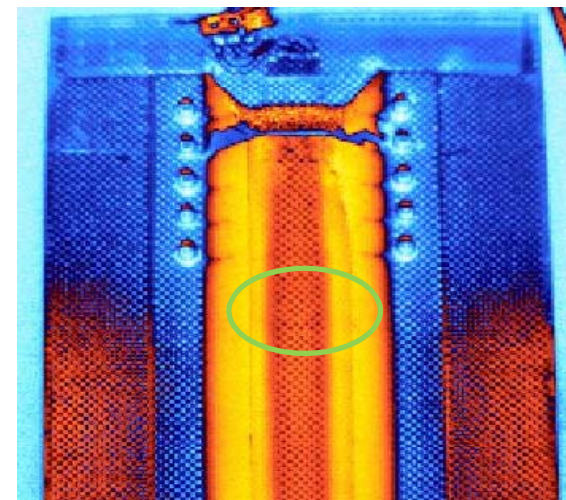
NDT CON ANALISI TERMOELASTICA

Questo tipo di analisi si basa sull'effetto termoelastico, che consiste nella variazione di temperatura che si verifica in un solido quando è soggetto a sollecitazioni in campo elastico. In questo modo è possibile ricostruire lo stato di sollecitazioni del componente partendo dalle variazioni di temperatura del pezzo, anche minime.

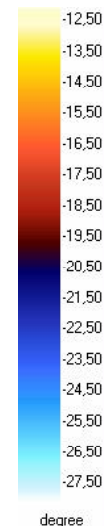
L'analisi mostra in tempo reale come la tecnica termoelastica possa essere usata facilmente come tecnica per controlli non distruttivi, per individuare eventuali difetti e le loro dimensioni, o cambi delle proprietà del materiale.



TSA



Lock-in



Confronto tra TSA e termografia lock-in (tecnica termografica usata per NDT)



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