

EXTENDED NON-DESTRUCTIVE TESTING OF COMPOSITE BONDS

Optimum bonding solutions for light-weight aircraft structures

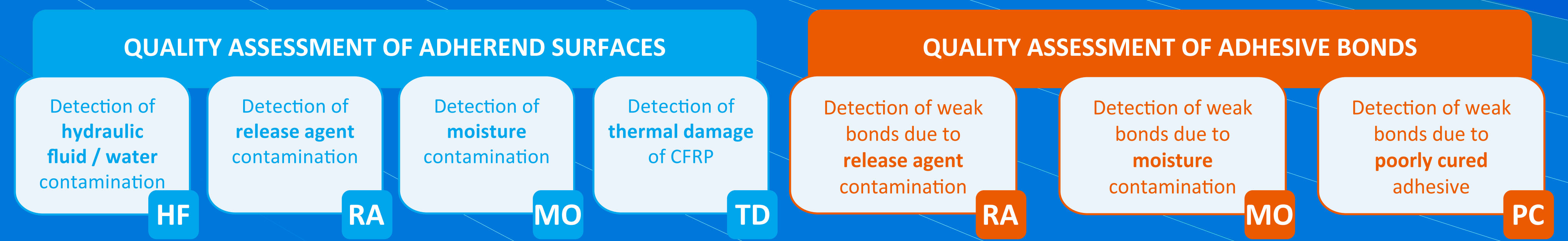


PROJECT OVERVIEW

ENCOMB provided advanced non-destructive testing (NDT) methods for pre and post-bond inspection of CFRP aircraft structural components in order to establish a reliable quality assurance concept for adhesive bonding. State-of-the-art NDT techniques were screened and the most suitable ones were further developed and adapted to important application scenarios with regard to aircraft manufacturing and in-service repair.

IDENTIFICATION OF FACTORS INFLUENCING ADHESIVE BOND QUALITY

Five application scenarios were identified to be of primary importance for the aircraft manufacturers along with the requirements for extended NDT technologies applying to each scenario.



QUALITY ASSESSMENT OF ADHEREND SURFACES & ADHESIVE BONDS

Adherend surfaces were characterised with conventional laboratory analysis methods (spectroscopic and optical techniques, contact angle measurements) to analyse their physico-chemical properties resulting from sample preparation.

Adhesively bonded samples were characterised with conventional NDT techniques (ultrasonic and x-ray inspection, μ -CT) to analyse their structural integrity resulting from sample preparation.

SCREENING, ADAPTATION & VALIDATION OF ADVANCED NDT TECHNIQUES

Advanced NDT technologies for the detection of selected physico-chemical properties of CFRP adherend surfaces and the quality of the adhesive bonds were identified, verified, developed, adapted, and validated for their potential to comply with the application scenarios and requirements.

Adherend surface quality	METHOD	PARTNER	Step 1				Step 2				VALIDATION
			Scenarios				Potential for detection of				
			RA	MO	HF	TD	RA	MO	HF	TD	
	X-ray fluorescence spectroscopy	IFAM	-	-	✓	-	used as reference methods				
	Infrared spectroscopy	IFAM	-	✓	✓	✓					
	Reflectometry / Ellipsometry	IFAM	-	-	-	-					
	Laser scanning vibrometry*	IMP PAN	✓	✓	✓	✓	○	●	○	○	Fail
	Optically stimulated electron emission	IFAM	✓	-	✓	✓	●	●	●	●	Pass
	Infrared spectroscopy	RECENDT	✓	✓	✓	✓	●	●	●	●	Pass
	Aerosol wetting test	IFAM	✓	-	✓	✓	●	○	●	●	Fail
	Portable Handheld FTIR spectroscopy	AGILENT	✓	✓	✓	✓	●	●	●	●	Pass
	Laser induced breakdown spectroscopy	IFAM	✓	-	✓	-	●	○	●	○	Pass
	THz/GHz reflectometry	IRE NASU	✓	✓	✓	-					Pass
	Optical fibre sensors*	EPFL	-	✓	✓	-	N/T	●	●	N/T	N/T
	Electrochemical impedance spectroscopy*	IFAM	-	✓	✓	-	N/T	●	N/T	N/T	N/T
	Electronic nose technology	ENEA	-	-	✓	-	●	●	●	N/T	Fail
	Dual-band active thermography	IZFP	-	-	-	-	○	●	●	●	Fail
	Laser induced fluorescence	IMP PAN	-	-	-	✓	○	○	●	●	Fail
	THz technology	RECENDT	-	-	-	-					
	Optical coherence tomography	RECENDT	-	-	-	-					

✓ : Clear detection of contaminant, differentiable from reference surface state
- : No differentiation from reference state

● : High
○ : Low

○ : No
N/T : Not Tested

* : With Structure Integrated Sensor

Adhesive bond quality	TECHNIQUE	PARTNER	Step 1			Step 2			VALIDATION
			Scenarios			Potential to detect weak bonds caused by			
			RA	MO	PC	RA	MO	PC	
	Active thermography using ultrasonic excitation	EADS-D	-	-	-				
	Terahertz technology	IRE NASU	-	-	-	○	○	○	N/T
	Linear Ultrasound	UnivBris	✓	-	-	●	N/T	○	Uncertain
	Nonlinear ultrasound	UnivBris	✓	-	-	●	N/T	○	Pass
	LASAT technique	CNRS	✓	-	-	●	●	●	Pass
	Laser ultrasound	RECENDT	-	-	-	○	○	○	Fail
	Active thermography using optical excitation	IZFP	✓	✓	-	●	●	N/T	Uncertain
	Laser scanning vibrometry*	IMP PAN	-	✓	-	○	●	●	Fail
	Electromechanical impedance*	IMP PAN	✓	✓	✓	●	●	●	Fail
	Ultrasonic frequency analysis	EADS-D	-	✓	-	●	●	○	Pass
	Laser ultrasound	EADS IW F	-	-	-	○	●	●	Fail
	Active thermography (for T _g analysis)	IFAM	-	-	-				

DEVELOPMENT OF A QUALITY ASSURANCE CONCEPT

IN-LINE AND IN-SERVICE QUALITY CONTROL

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