ATOMeS: Additive Topology Optimized Manufacturing & embedded Sensing

P. Attridge, S. Bajekal, T. El-Wardany, M. Klecka, J. Mantese, A. Nardi, N. Soldner, C. Tokgoz, D. Viens, X. Wu, and J. Zacchio, United Technologies Research Center, East Hartford, CT 06118

ABSTRACT

ATOMeS utilizes additive manufacturing (AM) processes (guided by physics-based models) to seamlessly embed sensors into high performance commercial and aerospace components; in the research and development platform of this effort - the airfoils of industrial natural gas turbines. Through a combination of rigorous structural and electromagnetic modelling, the embedding process is tailored to provide the necessary wireless signal and power while maintaining structural integrity. Real-time diagnostics are provided through the employment of a health-utilization-monitoring system (HUMS). More specifically, cold spray, a high velocity metal powder deposition AM process; is combined with direct metal laser sintering (DMLS) to produce contoured shapes with embedded sensors not easily realizable using conventional manufacturing. The goal of this versatile approach is to yield near net shape components with sensing elements protected by the severe environment of the manufactured part, without compromising its functionality or reducing part life.

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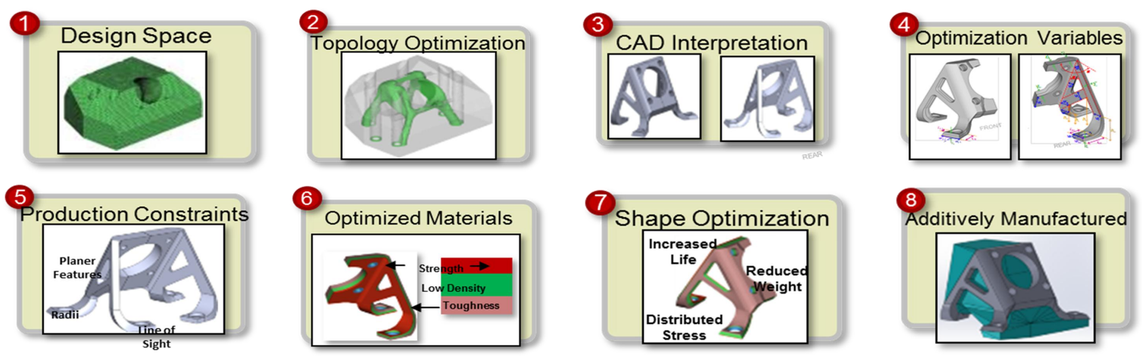
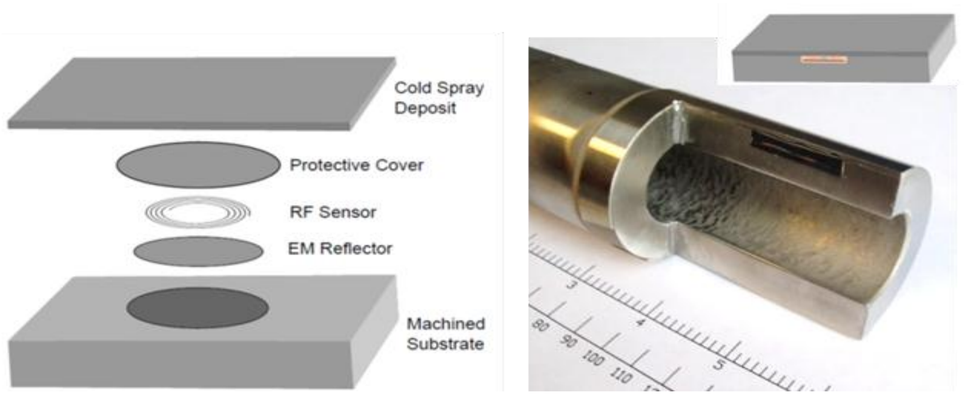
SMART PART

Embedded wireless sensor in structurally optimized component

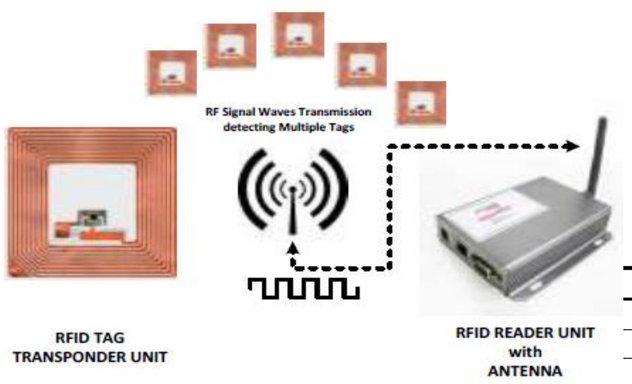
Structural Optimization through Modeling



Sensor Embedding Processes



Wireless Interconnectivity



	Regulations	Range	Data Speed
	Unregulated	10 cm	Low
	ISM Band Worldwide	1 m	Low to Moderate
	Short Range Devices	1-100 m	Moderate
868-870 MHz (Europe) 902-928 MHz (North America) UHF	ISM Band	1-2 m	Moderate to High
2450-5800 MHz (Microwave)	ISM Band	1-2 m	High
3.1-10 GHz (Microwave)	Ultra-wide Band	Upto 200 m	High

Heath and Utilization Monitoring System (HUMS)

Natural Gas Turbine Power