Laser-assisted winding of thermoplastic based composite for future launchers application.

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European Space Transportation faces strong challenges in the materials and technologies domain. Current families of civil and military launchers will be upgraded or replaced in the next decades. To meet the requirements of these new developments, Astrium Space Transportation, the European prime contractor for launchers, has established a composite materials and technologies development roadmap. This roadmap addresses the main requirements of the two major applications: next generations of civil launchers and military motor cases.

In order to offer competitive products, the following objectives have to be integrated. First, reducing the total ownership cost is of prime relevancy. In addition to that, environmental constraints (REACh) and sustainable development are other key drivers. Finally, robust processes have to be developed as well as integrated structures have to be designed so as to minimize the overall weight.

To reach these ambitious objectives, Out-Of-Autoclave (O.O.A) technologies and associated functionalized materials are the spinal column of Astrium roadmap on composite materials and technologies. In this context, a research programme is currently running to validate the technological breakthrough brought by the thermoplastic O.O.A composite technology. One main building block of this programme is the development of thermoplastic composite winding process with *in-situ* consolidation. The idea is to manufacture wound thermoplastic composite structures in one step process. Advantages resulting from this approach are numerous: shorter manufacturing cycles, lighter ground installations (no need of oven or autoclave), possibility to manufacture very large structures or ability of thermoplastics to weld together. Moreover, thermoplastic based composites offer improved damage resistance and higher thermal stability compared to conventional thermosets. They are also less affected by obsolescence issues and offer interesting recyclability possibilities.

Thermoplastics offer the ability to be reheated to be processed but *in-situ* consolidation of thermoplastic composite implies to dispose of an efficient heating method. Indeed, competitiveness of the overall manufacturing process is related to winding speed that has consequently to be maximized. It is laser heating that has been chosen. Carbon fibers and, to a less extent, polymer matrices, can be efficiently heated using infrared laser light. Resulting heating rates are very high, about several hundred of degrees per seconds. Finally, thanks to the development of diode technology, commercials laser systems are compact units that offer sufficient power (several kilowatts) and are easy to be implemented on standard winding machines.

The present communication will detail the technological work performed to develop laser-assisted winding of thermoplastic composite with *in-situ* consolidation. This notably includes the winding machine adaptation for laser compatibility and contact winding, the development of materials and specific testing methods, the structure design adjustment or process modelling activities. Finally, the manufacturing of the first technological demonstrators will be presented as well as future works.