Additive Technologies.
Method of manufacturing multilayer monocoque in Earth atmosphere.

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Additive technologies are widely known all around the world and implemented by a lot of companies. However the development of additive technology is focused on powder 3D-printing. Small-size items are fused with different in composition and dispersion powders. An impressive success is achieved in making metal robust details in different technology areas, for example, structure components of gas-turbine engine made of titan, aluminum and other alloys.

However there is an area of additive technologies that is paid almost no attention to. The uniqueness of this area is such that during an item fusing instead of metal powder should be used a graded wire of given composition and size. This direction has got a number of advantages over powder technologies. For example, density and leakage are much more foreseeable. The entrapped molecules of gas are influencing the quality of item less if the process of lining goes in inert atmosphere. Such a strong control of the fused layer height in a lot of cases is not required. The surface of manufactured item is smoother. The process of fusing with graded wire works on Earth and beyond it.

Let's have a look at some aspects of using the additive technology of large-size multilayer monocoque fused with graded metal wire.

The innovation development of techniques especially in aviation area asks for the continuous improvement of manufacturing process. At the dawn of aircraft manufacturing the fuselage made of wraparound-way construction lined with a shell was to fulfill 2 main functions i.e. withstand critical pressures being at the same time light weighted and provide the minimal resistance to airflow.

Improving, a fuselage became a metal aerodynamic cover that was the main structural element. The cover was strengthened with a frame made of lateral frames, side rails and bars. The lining was made of thin aluminum sheets fixed on metal frame. From 1920th wing air foils were manufactured in England as all-metal frame made of wing ribs and spars covered with metal sheets. Such construction of fuselage was called a monocoque (thin-walled monocoque).

For the moment the most challenging technology is considered to be when the fuselage and aircraft main plane is growing from the composite materials. The composite material usually consists of reinforcement and binder materials.

High-strength fibers made of glass, carbon and aromatic polyamide are usually used as reinforcement materials. These materials are used in the form of fibre, binder, fabric or net. The reinforcement material is being covered with binding material (matrix) that fixes the position of reinforcing fibers.

Having the forms filled in one or several layers and using an ascertain technology the composite construction is received and then finished.

The main advantages of the composite material constructions versus metal constructions are: the higher strength, minor weight, the better hardiness to aggressive environments effect.

But the composite technologies have got grave disadvantages.

For example, the same item made of metal is much cheaper than a composite one.

The technical process of making a composite item has got a low percent of automatization because a lot processes need manual work.

The ecological compatibility can be much disputed about.

Isn't it too early to discard metal constructions?

What would you say if there is a possibility to create a fuselage from nose to tail as a one piece metal layered shell? What would you say if this construction can descend from inside into strain members without any riveting, welding gluing and binding? The wing airfoil made the same way can be connected with flanged joint. That is all. The airframe is ready.

What is "a one piece metal layered shell"? Let's find out. For example we would like to make a 3d digital model of aerodynamic; it can be made of aluminum alloy from 0.5 to 1.5mm thick. From inside the cover transits to the basic structure made of the same material (or any other material as engineer would like it to be). There is a possibility to create basic structure in the form of plaiting strength members at different angles. And that would be a one piece construction. Some additional layers of covering and strength members can be added later. Moreover, the cover as well as strength members can change its thickness by changing elements stiffness at large or can be made of polymer material. In this way a metal-polymer construction will be formed.

These are not all possibilities of this new method. Different elements of the airframe can be constructed, for example, an aerodynamic shroud with built-in elements such as an antenna, wiring and even some electronic elements.

The additive technology meets the challenge of making an aircraft body in the form of a one piece metal layered shell of defined aerodynamic shape descending from inside into strain members without any riveting, welding, gluing and binding. The only place where it can't be applicable is the place where the body binds wing airfoils (flange mounting). Wing airfoil can be made with additive technology separately.

What can the manufacturing of airframe as a whole monocoque give us?

The whole body from nose to tail can be made automatically as a whole metal aerodynamic shell coordinated to digital model descending from inside into strain members. The whole air frame in this way will be a single structural element.

If the aircraft body and the wing foils are made with additive technology and fixed with flange mounting that could give the following advantages:

1. The airframe is much more solid than metal airframe made on the classical model of pleating and at least as solid as composite airframe.
2. The airframe is light weighted because of the lack of riveting, welding, gluing and binding items in the construction. Also it will be light weighted because of strength optimization
3. The manufacturing of such airframe will cost less because the process where computer-aided procedures are used takes less time, job cost and materials (for information: the cost of manufacturing composite parts, costs about 4-5 times more expensive than the same part made of metal)
4. The Structure safety is higher because the human factor is excluded

At this rate for the first time new methods and devices of manufacturing a one piece large scale metal polymer monocoques on an automatic basis are offered. By the way there are no analogues in the world and there are no such patents in Russia (patents: RU 2563063, RU 149949, RU 2609571). Potential Partners can ask us for a R&D Project.

These new methods and devices will bring the manufacturing of one piece multilayer metal polymer monocoque constructions into reality. Such constructions will be applicable in aerospace, shipbuilding, atomic, automobile and other industries.