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LASER-BASED EFFICIENT MANUFACTURE OF CARBON FIBER

Task

Thanks to their 2.5 fold higher specific strength in comparison to aluminum, carbon-fiber reinforced plastics (CFRP) offer an excellent starting point to realize lightweight constructions in the automobile or aviation sectors. A reason for the limited usage to date is, among others, the high manufacturing cost of carbon fibers. Almost the half of these costs can be traced back to the two-step heat treatment (stabilization and carbonization) of the carbonaceous precursor fibers (mostly out of polyacrylonitrile, PAN) into carbon fibers. This is due to the long duration in the furnace (up to two hours) as well as the high energy costs (temperatures up to 1,500 °C), which are necessary for the heat treatment.

Method

Thanks to the use of laser radiation, it is possible that higher heating rates and, thus, shorter stabilization periods can be attained in the furnace since the arising exothermal energy can be better guided away by the cool ambient air, thus, reducing the risk of thermal damage to the fibers. The focus of the research currently lies in developing a process control that allows the precursor fibers to be processed continuously by means of laser radiation. For this a test plant was set up, consisting of a spool unit, process chamber as well as beam source with adapted processing optics.

Result

The first test results on stabilizing in continuous operation have one expect potential time and energy savings of up to 30 percent. Research is still needed, however, on the homogeneity of the stabilization degree over the fiber cross-section as well as on identifying essential influential factors upon the mechanical parameters of the fibers.

Applications

As the process develops, a significant expansion of the application spectrum of CFRP components is expected due to significantly reduced manufacturing costs.

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3 Process chamber for laser processing.

4 Laser processing of PAN fibers.

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