This study demonstrates that low processing rate for producing polyacrylonitrile (PAN)-based carbon fiber is a critical to obtain a homogeneous radial microstructure with high resistance to oxidation, thereby resulting in their improved mechanical strength. The dry-jet wet spun PAN organic fibers were processed (e.g., stabilized and then carbonized) utilizing two different rates; one is 1.6 times longer than the other. The effect of processing rate on the microstructural evolutions of carbon fibers was analyzed by scanning electron microscopy after slow etching in air, as well as Raman mapping after graphitization. The rapidly processed fiber exhibited the multi-layered radial structure, which are caused by the radial-direction stretching of the extrudate in the spinning. In case of the slowly processed fiber, the layered radial structure formed in the spinning process was changed into a more homogeneous radial microstructure. The slowly processed fibers showed higher oxidation resistance, higher mechanical properties, and higher crystallinity than the rapidly processed one. Raman mapping confirmed that the microstructure developed during spinning was sustained even though fiber was thermally treated up to 2800 ℃.