TENSILE PROPERTIES OF HIGH STRENGTH PAN-BASED AND HIGH MODULUS PITCH-BASED HYBRID CARBON FIBER REINFORCED EPOXY MATRIX COMPOSITE

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Abstract. Fiber reinforced polymer matrix composites have become a dominant material in the aerospace, automotive and sporting goods industries. Some of these composites are useful, however, only in highly specialized situations where limitations such as brittle fracture behavior are considered. By mixing two or more types of fiber in a common matrix to form a hybrid composite it may be possible to create a material possessing the combined advantages of the individual composite. In the present work, the tensile properties of high strength PAN-based (IM600) and high modulus pitch-based (K13D) hybrid carbon fiber reinforced epoxy matrix composite were investigated. Fiber orientation of the hybrid composite was set to \([0_{\text{IM600}}/0_{\text{K13D}}]_{2S}\). The fiber volume fraction of the hybrid composite was 55.7 vol% (IM600: 29.3 vol%, K13D: 26.4 vol%). Tensile tests of CFRP specimens were performed using a universal testing machine (Shimadzu, Autograph AG-series) with a load cell of 100 kN. The crosshead speed of 5.0 mm/min was applied. All tests were conducted under the laboratory environment at room temperature. The tensile stress-strain curve of the hybrid composite shows a complicated shape (jagged trace). By the ultrahigh modulus pitch-based carbon fiber, the hybrid composite shows the high modulus in the initial stage of loading. Subsequently, when the ultrahigh modulus carbon fiber begin to fail, the ultrahigh strength fiber would hold the load (strength) and the material continues to endure high load without instantaneous failure. Because higher strength fiber can help the load for a certain time after failure occur, the hybrid composite could be considered one example of a material possessing
preventing instantaneous failure. The initial failure strain of the hybrid CFRP specimen was larger than that of the ultrahigh modulus carbon fiber (K13D) CFRP specimens. The Weibull statistical distributions of hybrid and mono (IM600 and K13D) CFRP specimens were also examined. The Weibull modulus for the mono CFRP specimens with fiber orientation was calculated to be 22.9 for the IM600 specimens and 14.4 for the K13D specimens, respectively. The Weibull modulus of the K13D CFRP specimens is lower than those of the IM600 CFRP specimens. The Weibull modulus for the hybrid CFRP specimen was calculated to be 39.6 for the initial fracture strength and 20.6 for the tensile fracture strength, respectively. The Weibull modulus for the initial fracture strength is higher than that for the K13D CFRP specimens and the Weibull modulus for the tensile fracture strength is almost similar to that for the IM600 CFRP specimens.