論 文 の 内 容 の 要 旨

論文題目　Effects of environmental factors on the mechanical properties of carbon fiber paper reinforced polyamide 6
（炭素繊維ペーパー強化ポリアミド６の力学特性に対する環境要因の影響に関する研究）

氏　　名　　何 向東

Carbon fiber reinforced plastics (CFRPs) have a wide range of applications in the fields of aerospace, transportation, sports, automobiles, etc. Compared to ceramic and metal materials, CFRPs have lower weight at the same level of mechanical performance. Recently, carbon fiber reinforced thermoplastics (CFRTP) are used extensively in order to reduce costs and improve productivity. For matrix used in CFRTP, polyamide 6 (PA6) is highly expected due to its excellent mechanical properties, low cost and great cohesiveness with carbon fibers. However, environmental factors such as moisture, temperature, thermal oxidation, etc. will lead to an oxidation reaction proceeding on polymer chains, thus result in the decrease of the molecular weight, subsequent deterioration in mechanical properties, increased yellowing, and eventually embrittlement. So, in this research, with the aim of confirming the mechanical performance of CFRTP in various environments, the effects of hydrothermal action, sea water, cyclic absorption and desorption, and thermal oxidation were researched experimentally and analytically. Carbon fiber paper reinforced thermoplastic (CPT) was chosen as the raw material. CPT specimens were made by compressed molding.

Moisture plays an important role in the performance degradation of PA6-based composites. Besides, with the pace of economic globalization, the marine industry is becoming a new economic growth point for some coastal countries and region. Therefore, the absorption process in fresh water and sea water of CPT were analyzed in chapter 2. Water absorption ratio and diffusion coefficient were calculated to evaluate the diffusion behavior of water molecules in CPT. The flexural properties of CPT with different water contents were studied by three-point bending test. Cyclic absorption and desorption tests were conducted to analyze the role of water molecules in water-absorbed CPT materials. The role of water molecules as plasticizers was identified and cyclic water absorption will result in slow decrease of mechanical properties.

In order to analyze the performance of CPT material under long-term aging in water environment, long-term aging tests in fresh water and sea water were conducted in chapter 3. CPT specimens were kept in fresh water and sea water for 6 months, and the flexural properties of these specimens were tested at one-month interval. Surface morphology of these specimens was observed by microscope to evaluate the hydrothermal effects on CPT materials. Thermodynamic properties were studied to analyze the effect of aging from the perspective of resin crystallization. The analysis of the chemical structure of matrix showed that polymer chain scission and degradation are important factors leading to the decline of mechanical performance.

Thermal oxidation resistance was also analyzed by thermo-oxidized test to evaluate the high temperature tolerance. CPT materials can keep a relatively stable properties after 100 hours thermal oxidation at 160℃. The results gave guidance for the application of CPT materials in the field of high temperature. Related results are shown in chapter 4.