Abstract

In this Thesis, micromechanical analyzes of a novel unidirectional continuous fuzzy fiber reinforced composite (**FFRC**) and a novel short fuzzy fiber reinforced composite (**SFFRC**) have been carried out. The distinct constructional feature of these composites is that the uniformly spaced straight or sinusoidally wavy carbon nanotubes (**CNT**s) are radially grown on the circumferential surfaces of the carbon fiber reinforcements. Such an advanced fiber augmented with radially grown **CNT**s is called as a fuzzy fiber.

Micromechanical models based on the mechanics of materials (**MOM**) approach, the Mori Tanaka (**MT**) method, the method of cells (**MOC**) approach and the finite element (**FE**) method have been developed to predict the effective elastic properties of these novel **FFRC** and **SFFRC** with and without the consideration of an interphase between a **CNT** and the polymer matrix. Such an interphase is the continuum representation of the non-bonded van dar Waals interaction between a **CNT** and the polymer matrix. The micromechanical analyses revealed that the values of the transverse effective elastic constants of the **FFRC** and the **SFFRC** are significantly improved over their values without **CNTs**. Such enhancement is attributed to the transverse stiffening of the polymer matrix surrounding the carbon fiber by the radially grown **CNT**s. The non-bonded van der Waals interaction between a **CNT** and the polymer matrix does not affect the in-plane effective elastic coefficients of the **FFRC** and the **SFFRC** and its effects on the other effective elastic coefficients of the **FFRC** and the **SFFRC** are also not pronounced. The effective values of the transverse elastic coefficients of the **FFRC** and the **SFFRC** marginally increase with the increase in the **CNT** diameter.

Pronounced effects of the waviness of the radially grown **CNT**s on the values of the effective elastic properties of the **FFRC** are observed. If the plane of the radially grown wavy **CNTs** is coplanar with the plane of the carbon fiber such that amplitudes of the **CNT**s are parallel to the length of the carbon fiber then the axial effective elastic properties of the **FFRC** are significantly improved while the transverse effective elastic properties of the **FFRC** are decreased as compared to those with straight **CNT**s.

A three-phase shear lag model of the novel **SFFRC** containing straight or sinusoidally wavy **CNT**s has been developed to investigate the stress transfer characteristics of the **SFFRC**. The novelty of the shear lag model is that both the axial and the radial deformations of the constituent phases of the **RVE** of the **SFFRC** are considered while the **RVE** is subjected to both the axial and the radial loadings. The shear lag model revealed that if the plane of the waviness of the **CNTs** are coplanar with the plane of the carbon fiber such that the amplitudes of the **CNTs** are parallel to the length of the carbon fiber then the stress transfer characteristics of the **SFFRC** are significantly improved compared to that of the composite with and without the straight **CNTs**.

Analytical micromechanics models based on the **MOC** approach and the **MT** method have also been developed to estimate the effective thermoelastic properties of the continuous **FFRC** containing straight **CNT**s. It is found that the transverse effective thermal expansion coefficients of the **FFRC** are significantly decreased due to the radially grown **CNTs** on the circumferential surface of the carbon fiber over their values without **CNTs**. Effect of temperature deviation on the effective thermal expansion coefficients of the **FFRC** is found to be negligible.