

## Effect of Broken Glass Particle on Stress Transfer of Nylon Matrix Composite

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Some of the material demands in the advanced industries cannot be fulfilled by monolithic materials. Therefore, composite materials have been developed. The combination of desired properties of thermoplastics and glass particles (high strength and high modulus) is the aim of composites production. Particles are becoming increasingly popular reinforcing elements in products made by injection molding. Particles reinforcement allows the polymer to be processed employing the same methods as those used for unreinforced polymers. The loads are not directly applied to the reinforcements, but they are applied to the matrix and some of the loads applied are transferred to the particles. The development of micromechanics equations for the particulate composites follows along the same lines as those for the short fiber reinforced composites. Particles are used to increase the strength or other properties of inexpensive materials during reinforcement with other matrix materials. The objective of this study is to analyse the particle breaking effect in composite made of nylon 66 (PA) matrix reinforced with glass particles, in which the particles diameters of 19.61, 26.15, 39.22 and 78.45  $\mu\text{m}$  were used. A volume fraction of 20 % was assumed in each model.

**Keywords:** Broken particle, Nylon matrix, Composite, Stress transfer, Finite element.

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### 1. INTRODUCTION

The different types of composite materials are defined according to the nature of the reinforcements which can be of very different natures. The reinforcements are particles, short or continuous fibers [1]. The addition of stiff reinforcements in thermoplastics is an established practice in the polymer industry, introducing a stiff second phase, substantial improvements in stiffness, strength, creep performance, fracture toughness, can be obtained [2]. Fibers are often used as reinforcement, although this often results in anisotropic properties. This can cause problems and variations in component dimensions. The high costs and technical difficulties associated with the evolution of the manufacture of fiber reinforced composites sometimes limit their use in many applications [3]. Particulate fillers in the form of spheres can sometimes be a better choice when tight tolerances or isotropic properties are required [2].

A composite material is said to be particulate when its reinforcement is in the form of particles that do not have a preferred dimension (Fig.1). They are used to increase the properties of materials during the reinforcement of the matrix [4], they are used to improve characteristics such as the rigidity of the matrix, the resistance to abrasion or the resistance to temperature, to increase the modulus of the composite, decrease permeability and also decrease ductility. They are also often used to reduce the cost of the material [5]. The geometric arrangement of the constituents and the shapes of the particles only play a secondary role [6], generally, the particles are spherical, ellipsoidal, polyhedral or irregularly shaped, they are added to a liquid matrix which subsequently solidifies in a certain process.

Young's modulus is significantly improved by adding micro and nanoparticles to a polymer matrix because the hard particles have much higher stiffness values

than the matrix [7]. The particles can be treated or untreated during reinforcement. Particle-reinforced materials are more attractive due to their cost-effectiveness, isotropic properties, and ability to be processed using technology similar to that used for monolithic materials [8]. The behavior of the macroscopically isotropic particle-reinforced two-phase composite is mainly determined by the behavior of the constituent materials, the volume fraction of the matrix and the inhomogeneities.



**Fig. 1** – Different types of particles [5]

The purpose of this work is to analyze the broken particle effect of glass particle reinforced nylon 66 (PA) matrix composites considering the interaction between the matrix and particles interface. Particle reinforced composite is subjected to the longitudinal tensile loading.

### 2. FAILURE IN PARTICLE COMPOSITE

The incorporation of the particles in a matrix causes stress concentrations in the peripheries of the particle when the composite is subjected to loading [9]. Failure processes in particle-reinforced composites are related to the fundamental problem of a matrix crack interacting with second-phase particles [10]. The design against brittle fracture in composites is of critical importance [11]. Transmission electron microscopy has been used, but it is difficult to produce samples thin enough for the technique to be useful due to the presence of fragile reinforcements [12]. According to Vincent CARMONA [13], when the damage sequence is observed, the first visible mechanism is the rupture of large particles.

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