



Polymer Modifiers

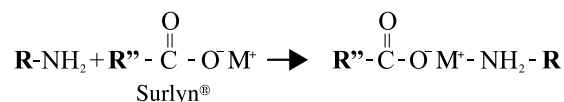
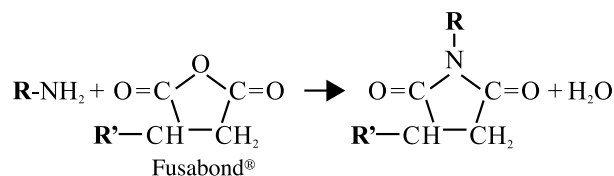
Polyamide Toughening Using DuPont Polymer Modifiers



DuPont polymer modifiers are used in toughened polyamide (nylon) resins, ranging from general-purpose grades to leading supertough formulations.

Polyamide (nylon) thermoplastic resins offer an excellent balance of processibility and performance properties and therefore are used widely. Of the many types of nylon available, the most popular are nylon 6 (PA 6) and nylon 6,6 (PA 6,6). However, some end-use applications for these resins require improved impact performance at ambient or low temperatures. For these applications, toughened grades of nylon can be used.

DuPont offers several polymer modifier technologies that can be used for nylon toughening. These technologies typically combine increased low-temperature impact properties, with good adhesion to the nylon. The adhesion is achieved by the reaction of amine or carboxylic acid end-groups of the nylon polymer with the functional group of the tougheners. Selected reactions are shown on right:



By varying the amount and type of toughener used, different levels of nylon toughness can be achieved. Three categories of tougheners are generally recognized:

General-purpose toughener – provides impact strength measured by notched Izod test of about 100 to 210 J/m or about 2 to 4 ft-lb/in. at test temperature.

Intermediate toughener – provides impact strength measured by notched Izod test of about 160 to 320 J/m or about 3 to 6 ft-lb/in. at test temperature.

Super toughener – results in no break in the notched Izod test, with impact strength typically greater than 800 J/m or greater than 15 ft-lb/in. at the test temperature.

The impact strength measured by notched Izod testing depends very much on test temperature. Thus, a nylon modifier may provide super-toughness at room temperature, yet only achieve general-purpose toughness at -40°C (-40°F) test temperatures.

Impact modification of nylon 6

For toughening PA6, DuPont Fusabond® N493 is recommended. The level of toughening depends on the amount of modifier used. A wide range of toughness, from general purpose to super-toughness, can be obtained by the varying the amount of Fusabond® (see Figure 1). Super-tough properties can be achieved at 15 wt% of Fusabond® N493.

For intermediate toughening, Surlyn® 9020 is recommended for PA6 besides Fusabond® N493 (see Figure 2). Advantages of using Surlyn® modifier include its FDA compliance (for direct food contact), its low color, excellent surface finish, and short cycle time.

Note: The testing for PA6 modification was made using Ultramid® B-3 (BASF) compounded with a twin screw extruder.

Impact modification of nylon 6,6

For PA6,6 impact modification, DuPont Fusabond® N 416 or Fusabond® N493 is recommended. Fusabond® N416 gives good properties for PA6,6 due to its relatively high level of high functionality. The level of toughening with various amount of Fusabond® N416 for PA6,6 is shown in Figure 3.

For intermediate and general purpose toughening of PA6,6, Surlyn® and Fusabond® modifier products can be used (see Figure 4). Surlyn® 9020 provides outstanding toughening properties at low level (6.5%). Advantages of using Surlyn® include its FDA compliance for direct food contact, its low color, excellent surface finish and short molding cycle time.

Note: The testing for PA6,6 modification was made using DuPont Zytel® 101 NC010 compounded with a twin extruder.

Figure 1 Notched Izod of PA6 Modified with Various Levels of Fusabond®N493

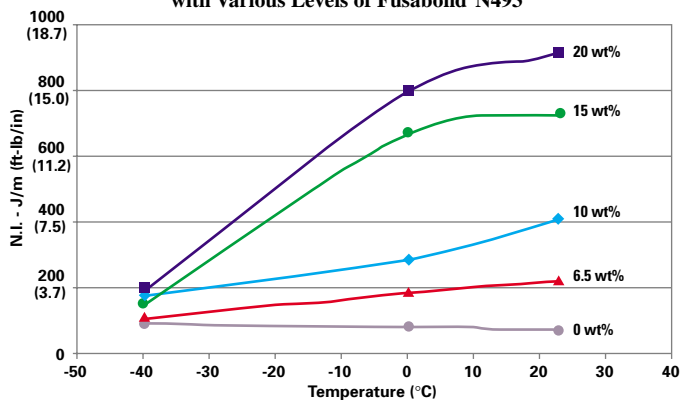


Figure 2 Notched Izod of PA6 Modified with Fusabond®N493, Surlyn® 9020 at 6.5 wt% Level

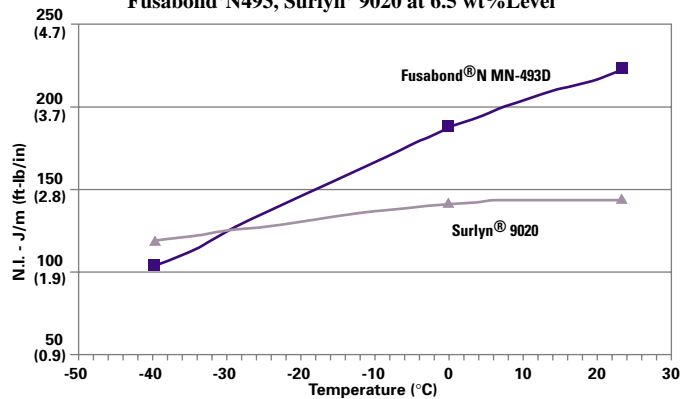


Figure 3 Notched Izod of PA6,6 Modified with Various Levels of Fusabond®N416

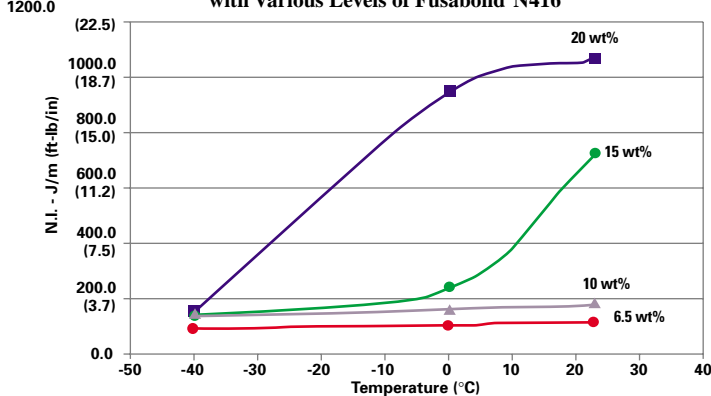
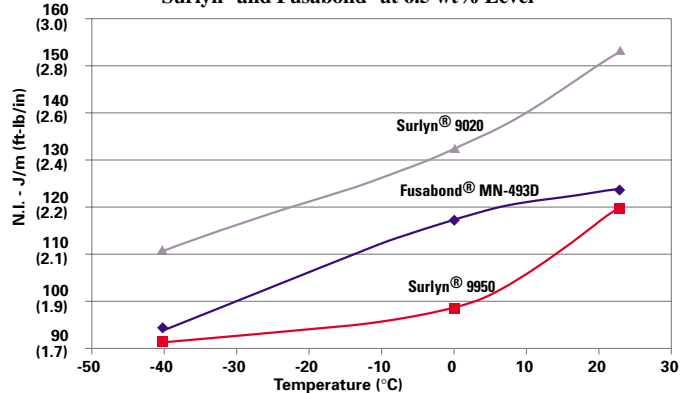


Figure 4 Notched Izod of PA6,6 Modified with Surlyn® and Fusabond® at 6.5 wt% Level



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