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METHOD OF MAKING AMIDE-IMIDE RESINS, AROMATIC AMIDES AND AROMATIC POLYAMIDE RESINS

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ABSTRACT OF THE DISCLOSURE

A method of making essentially totally imidized polyamide-imide resins, aromatic amides, and other aromatic polyamide resins which can be applied to articles without the resins undergoing substantial chemical change as the resins are being applied, and intermediates formed during the performance of the method. Specific polyamide-imide resins which can be made in accordance with the method of the invention are those derived from tricarboxylic acids or anhydrides thereof, such as trimellitic acid or trimellitic acid anhydride, and a diisocyanate, such as p,p'-diphenyl methane diisocyanate. The method comprises an initial reaction under mild conditions and a subsequent reaction under more severe conditions.

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of application Ser. No. 819,954, filed Apr. 28, 1969, now abandoned.

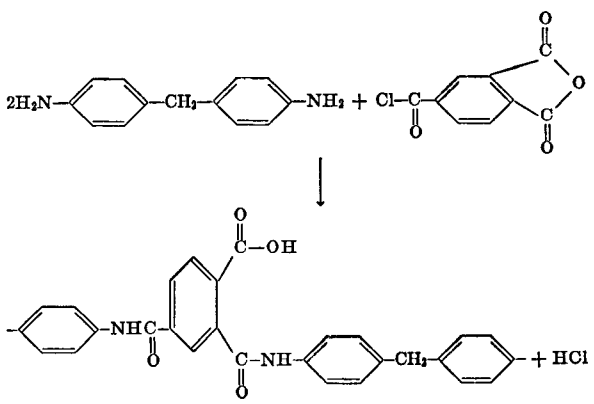
BACKGROUND OF THE INVENTION

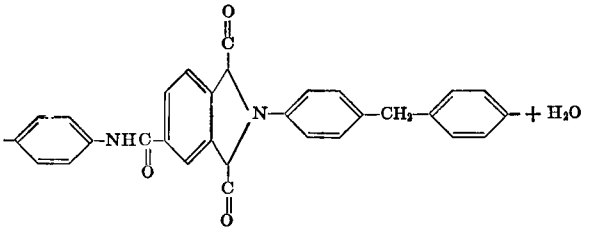
Field of the invention

This invention relates to polyamide-imide resins, aromatic amides, and other aromatic polyamide resins and modifications thereof. More particularly, this invention relates to a method of making polyamide-imide resins, aromatic amides, and other aromatic polyamide resins and modifications thereof, and intermediates formed during the performance thereof, and the application of such materials to articles, for example, to electrical conductors as a coating thereon and to insulated electrical conductors as an overcoat superposed over a coat of base insulation.

DESCRIPTION OF THE PRIOR ART

Polyamide-imide resins have heretofore been formed by converting the carboxyl group of a tricarboxylic acid anhydride, for example, trimellitic anhydride, into an acid halide, freeing the acid halide from excess halide-containing reagent, and reacting the same with a diamine, for example, methylene dianiline, as follows:





The reaction between the acid chloride group and an amine group produces an amide with a hydrogen halide reaction by-product and the reaction between an amine group and the anhydride group produces an amide-acid group. The amide-acid group, then is converted or cured into an imide in accordance with the above reaction which produces water. Both of the reaction by-products, hydrogen halide and water, must be eliminated from the resin prior to or during curing of the resin.

Thus, the conventional methods of making polyamide-imide resins, aromatic amides, and other aromatic polyamide resins each comprise several reaction steps and the separation of reaction products from the resulting resin. For these reasons, it is highly desirable to provide an improved method for making polyamide-imide resins, aromatic amides, and other aromatic polyamide resins.

With particular reference to the polyamide-imide resins several difficulties have been experienced when these resins are used as coatings on articles such as magnet wire. First, since these resins in an uncured state include an amide-acid group and may include hydrochloric acid or organic chloride which has not been completely eliminated from the resin solution, these resins conventionally require stainless steel equipment, rather than less expensive non-stainless equipment. Also, conventionally, it has often not been possible to apply a uniform, smooth coat of cured resin on such articles. For example, a commercial polyamide-imide resin (AI type 10 resin, or AI537 enamel, as sold by Amoco Chemicals Company) when applied to a magnet wire and cured, yields a wire enamel which has several deficiencies, often starting with poor runability, slow curing, requiring high temperatures, and often adhering poorly to a copper substrate. Many of the objectionable properties associated with coatings of these resins can be attributed to the tendency of such resins to blister. The blistering of the resin occurs during the "curing" of the resin and is due to the expulsion of the reaction products aforementioned, water and any halide reaction product remaining, from the resin. While the hydrochloric acid or other halide-containing reaction products can be eliminated from the resin prior to or during application, it has generally been known that such resins must be applied from solution partly or wholly in an amide-acid form in order to render the resins soluble. For these reasons, it is highly desirable to provide an improved method for making essentially completely imidized polyamide-imide resins, aromatic amides, and other aromatic polyamide resins which can be applied to articles, for example, magnet wire, without the resins undergoing substantial chemical change or requiring the expulsion of unwanted reaction by-products, during application.

Others have reacted carboxylic acids and acid anhydrides with isocyanates for a variety of purposes. Soluble aromatic amide anhydrides for use as curing agents for epoxy resins have been made by reacting aromatic acid anhydrides with isocyanates. Fusible aliphatic polyamides have been prepared by reacting totally aliphatic carboxylic acids and isocyanates. Aromatic carboxylic acid anhydrides have also been reacted with an excess of amomatic isocyanates to form imide containing polyisocyanates, tri-