LOW-FRICTION, WEAR-RESISTANT MATERIAL

FIELD OF THE INVENTION

This invention relates to a low-friction, wear-resistant material and to a process for producing it. Specifically, the material consists of a variably shaped metallic or non-metallic substrate having an outer layer composed of uniformly disposed spheroidal to spherical shaped particles partly embedded in a matrix secured to the substrate so as to provide a substantially uniformly wavy surface void of any sharp projections. The substrate may also be composed of the uniformly disposed particles thus forming a homogeneous material.

DESCRIPTION OF THE PRIOR ART

The textile industry is one example of a prime user of low-friction, wear-resistant materials. These materials are used mainly as the component parts of the textile apparatus, such as rolls, pins, guides and the like, that commonly come in surface contact with running fibers. The surface of these parts is frequently required to have a low-friction value so that when the fiber moves over the surface, the coefficient of friction between the two surfaces will be at a minimum. The fiber is usually under tension coming off these component parts and any unnecessary increase or change in the coefficient of friction between the surfaces will not only result in non-uniform and erratic performance of the apparatus but could also cause actual breakage of the fiber.

Ceramic materials have wear-resistant characteristics and therefore have been extensively used as component parts in apparatuses designed for textile applications. However, ceramic parts are susceptible to breakage and in addition, ceramic material is unsuitable for transferring the heat buildup associated with the contact friction between the moving fibers and the surface of the ceramic parts. Moreover, it is very difficult to produce a low-friction surface on ceramic parts. To compensate for the mechanical strength deficiencies and poor heat transfer capabilities of ceramic parts, the textile industry has resorted to the use of component parts composed of metallic substrates coated with an outer layer of ceramic material. Although these coated metallic parts are sufficiently strong to withstand breakage and are capable of dissipating the heat buildup during a production run, they are not as desirable as the pure ceramic parts because the as-sprayed or other wise deposited ceramic outer layer is usually too rough and jagged for textile applications. Attempts for abrasively smoothing the as-deposited outer ceramic layer has succeeded in producing a low-friction surface part but upon subjecting it to a textile production run environment, the surface layer wears thus increasing the coefficient of friction between it and the moving fibers. It is suggested that the as-deposited ceramic layer be contacted with an abrasive material for a time period only sufficient to smooth the sharp peaks resulting from the protruding particles of the coating material on the surface. Although an improved as-coated part would be produced, there is no commercial means avaiable for insuring that only the protruding peaks would be abrasively removed and that such removal would result in a rounded surface for the protruding particles rather than a flat surface at their uppermost extremities.

A further advancement in the textile industry was achieved with the production of chromium plated metallic parts having a "matte" type finish on the surface resembling the surface of the common orange. These chromium plated surfaces are admirably suited for use in providing low-friction surfaces which are gentle to textile materials. Chromium plated materials, however, are expensive to produce and do not exhibit a high degree of wear resistance.

Articles having a wear-resistant coating applied by various high temperature flame spraying techniques, such as detonation gun plating and plasma arc spraying, are also in wide use throughout the textile industry. While flame sprayed coatings are generally well suited for many textile applications, a uniform deposition of a coating to a complex surface configuration is difficult to apply since most spraying processes are limited to the line of sight travelled by the coating particles. Also flame spraying requires complex processing steps in their application thus rendering them even more expensive to apply than chromium platings.

Although the high temperature flame spraying techniques provide an advancement in the art of producing textile component parts, the need for producing complex configured parts having a low-friction, wear-resistant surface is still desired. The present invention is directed to fulfilling this desired need.

SUMMARY OF THE INVENTION

This invention relates to materials having a low-friction, wear-resistant surface and to a process for producing it. Specifically, the invention relates to a variably shaped material having at least one outer layer of highly densified, uniformly disposed spheroidal to spherical shaped wear-resistant particles, such as metallic-oxide particles, protruding outward from a matrix secured to a metallic or non-metallic substrate thus providing a "matte" type surface finish resembling a sinusoidal polar waveform. When the substrate is also composed of the same uniformly disposed particles, the only requirement is that the outer surface have a "matte" type finish.

The criteria of the spheroidal particles are that they have wear-resistant characteristics, a melting point above the temperature of the heat buildup in its intended use which is usually above 200°C., and be amenable to the particular material intended to contact them in their designed application. In addition, the wear-resistant particles have to be capable of being formed into spheroidal to spherical shapes so that once they are uniformly disposed and partly embedded in a matrix of plastic or the like, their protruding segments will produce a "matte" type finish. Thus when tension-subjected, long, thin, film or fibrous materials are pulled over a surface so formed, the materials will tangentially contact the rounded protruded wear-resistant particles only, thereby greatly minimizing the actual contact between the materials and the finished surface. This minimum contact area between the fibrous material and the finished surface is highly desirable in achieving low-friction characteristics.

Suitable wear-resistant particles for use in this invention include metal oxides, metal carbides, metal borides, metal nitrides and metal silicides in any combination or mixture thereof. Examples of some metal oxides include such compounds as alumina (Al_2O_3), silica (SiO_2), chromium sesquioxide (Cr_2O_3), hafnium oxide