METHOD FOR MAKING MICROSTRUCTURED TOOLS HAVING ~~INTERSPERSED~~DISCONTINUOUS TOPOGRAPHIES, AND ARTICLES PRODUCED THEREFROM

BACKGROUND

[0001] Microstructured composite films are produced using metal molding tools of exacting dimensions that can be time consuming and expensive to make. Many methods for using a patterned tool to replicate a complementary pattern in the surface of a film are well known. However, in many instances the pattern resulting from the replication method may be limited by the tool (e.g., certain pattern configurations do not lend themselves to being replicated by conventional replication methods). Many times there is a need to produce films that bear alphanumerics, security marks, light modulating features, or customized decorative patterns.

SUMMARY

[0002] What is needed is a method, preferably that is relatively rapid and relatively low-cost, for creating a variety of differentially pattern cured microstructured articles without permanent physical modification of a microreplication tool.

[0003] In one ~~aspect~~embodiment, methods described herein include making a molding tool, by coating a radiation curable resin on the first microstructured surface of the molding tool, exposing the radiation curable resin to a patterned irradiation, and then removing non-irradiated radiation curable resin from the molding tool to provide a modified microstructured surface on the molding tool. Methods are also disclosed herein for introducing at least one region of a second microstructured surface to the first microstructured surface of the first molding tool, by contacting a second molding tool having a second microstructured surface (which is typically coated with a release agent) against a radiation curable resin coated on the first microstructured surface of the first molding tool prior to the patterned irradiation, performing the patterned irradiation and subsequently removing the second molding tool and the radiation curable resin from at least one non-irradiated region of the modified first molding tool. In some embodiments, the radiation curable material is selected to be sufficiently durable, after irradiation, to withstand molding processes as part of the modified first molding tool, while also being removable (e.g., by physical or chemical treatment), to restore the modified first molding tool to its unmodified condition. The modified first molding tool can optionally be treated to make the modification more permanent, using methods known to those in the art (e.g., by depositing a metal layer on the modified microstructured surface). The modified first molding tool can be used as a molding tool in at least

some embodiments of methods described herein for making differentially pattern cured microstructured articles.

[0004] In ~~some embodiments~~an aspect, the present disclosure describes a method of making a molding tool, the method comprising providing a first molding tool having a first microstructured surface that includes a first plurality of cavities; providing a second molding tool having a second microstructured surface that includes a second plurality of cavities; filling at least one of the first or second pluralities of cavities with a radiation curable resin; contacting the first and second molding tools against the radiation curable resin such that the first and second pluralities of cavities face each other with a layer of the radiation curable resin therebetween and in contact with the first and second pluralities of cavities; exposing the layer of the radiation curable resin to a patterned irradiation through at least one of the first molding tool or the second molding tool to provide a corresponding partially cured resin layer comprising at least one first region and at least one second region, wherein the at least one first region is irradiated by the patterned irradiation and the at least one second region is not irradiated by the patterned irradiation, and wherein at least one of the first molding tool or the second molding tool is transparent to the patterned irradiation; separating the second molding tool from the partially cured resin; and separating the non-irradiated regions of the partially cured resin from the first molding tool, to provide a molding tool having a microstructured surface that includes a pattern of a matrix of first microstructural features and at least one discontinuous region of second microstructural features.

[0005] In another ~~aspect~~embodiment, the present disclosure describes an article having a first major surface comprising first microstructural features within a matrix of second microstructural features, wherein the first microstructural features are discontinuous, wherein collectively the first and second microstructural features form a pattern visible at least when viewed normal to the first major surface, and wherein the first and second microstructural features are independently selected from the group consisting of cones, diffraction gratings, lenticulars, segments of a sphere, pyramids, cylinders, fresnels, and prisms.

[0006] In another ~~aspect~~embodiment, the present disclosure describes an article having a first major surface comprising first microstructural features and second microstructural features arranged in a pattern visible at least when viewed normal to the first major surface, wherein the first and second microstructural features are different relative to each other, and are selected from the group consisting of cones, diffraction gratings, lenticulars, segments of a sphere, pyramids, cylinders, fresnels, and prisms.

[0007] "Cured" in reference to polymers refers to polymers made by cross-linking liquid, flowable or formable monomeric or oligomeric precursors by application of an appropriate energy