

BACKGROUND OF THE INVENTION

Motor vehicles are almost always operated in the out of doors and are frequently parked there. It is therefore very common for their occupants to have wet or muddy feet--if the occupants have not just finished an outdoor activity, at least they have had to walk across a possibly wet, snowy or muddy surface to access their vehicles. For decades, therefore, vehicle owners have been attempting to protect the enclosed interiors of their vehicles (cars, trucks, SUBSSUVs) from what they themselves track into them. The conventional solution to this has been to provide a vehicle floor mat which may be periodically removed by the owner and cleaned.

Human beings have a tendency to move their feet around, and foot motion is an absolute requirement in operating most vehicles. This has caused a problem, in that the occupants of a vehicle have a tendency to push around the floor mats with their feet. The floor mats end up not being centered on the area protected, or pushed up so as to occlude the gas, brake or clutch pedals, or bunched up or folded over--all undesirable conditions. One objective of floor mat manufacturers has therefore been to provide a floor mat that will stay put and which will not adversely affect vehicle operation.

The foot wells of cars, trucks and SUBSSUVs vary in size in shape from one model of vehicle to the next. Floor mat manufacturers have noticed that floor mats which at least approximately conform to the shape of the bottom surface of the foot well stay in place better and offer more protection. It is also common for such floor mats, where provided for front seat foot wells, to have portions which are meant to lie against the ~~fireballs~~firewalls or front surfaces of the foot wells. Even as so extended it is not too hard to provide a floor mat of flexible material that will approximately conform to these two surfaces, as the designer only has to mark a two-dimensional periphery of the mat in providing one which will fit reasonably well.

More recently, vehicle floor trays have come onto the market. Most front-seat vehicle foot wells are actually three-dimensional concave shapes, typically with complex curved surfaces. Floor trays have sidewalls that offer enhanced protection to the surfaces surrounding the vehicle floor, as might be needed against wearers with very muddy or snowy shoes. Conventional vehicle floor trays try to fit into these three-dimensional cavities, but so far their fit to the surfaces that they are supposed to protect has been less than optimum. A conventional vehicle floor tray is typically molded of a single-ply rubber or plastic material, exhibits enough stiffness to retain a three-dimensional shape, but is also at least somewhat flexible. Fitting such a tray to the complex three-dimensional surface of a vehicle foot well has proven to be difficult, and the products currently in the marketplace have limited consumer acceptance because of their loose fit inside the foot well. There is often, and in many places, a considerable space between the exterior wall of these conventional trays and the interior surface of the foot well. This causes the wall to noticeably deform when the occupant's foot contacts it. Vehicle owners have a tendency to dislike floor trays which rattle, deform, shift and flop about. A need therefore persists for a floor tray that will have a more exact fit to the vehicle foot well for which it is provided, that stays in place once it is installed, and that provides a more solid and certain feel to the occupants' feet.

Some vehicle floor mats that are now on the market have fluid reservoirs built into them. Particularly in cold or wet climates, dirty water has a tendency to be shed onto the floor mat,

where it persists until it evaporates. If there is enough of it, it will leak off of the floor mat and stain the carpeting of the foot well that the mat was meant to protect. These reservoirs typically are recessed areas in the mats that provide the mats with an enhanced ability to retain snow-melt and the like, until the water evaporates or can be disposed of by the vehicle owner or user. One advanced design places treads in the middle of the reservoir, such that the feet of the occupant are held above any fluid that the reservoir collects. But including such a reservoir within a floor tray that otherwise has an acceptable fit to the surface of a vehicle foot well has not yet been done, since there are problems in incorporating a three-dimensional liquid-holding vessel into a product that ideally conforms, on its lower surface, to the surface of the foot well. Further, a reservoir which collects drip water from a large surface, such as a vehicle floor tray, will exhibit more problems in keeping the collected fluid from sloshing about in a moving vehicle.

Conventional vehicle floor mats and trays are molded from a single rubber or plastic material. The selection of this material is controlled by its cost, its resistance to shear forces, its tensile strength, its abrasion resistance, its ability to conform to the surface of the vehicle foot well, its sound-deadening properties and how slippery or ~~non-slippery~~nonslippery it is relative to the occupants' feet, with ~~non-slipperiness~~nonslipperiness (having a relatively high coefficient of friction) being advantageous. Often the designer must make ~~trade-off~~tradeoffs among these different design constraints in specifying the material from which the tray or mat is to be made.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided a vehicle floor cover, mat or tray which is removably ~~installable~~installable by a consumer and which is formed of at least three layers that are bonded together, preferably by ~~contusion~~coextrusion. The three layers include a central layer whose composition is distinct from a bottom layer and a top layer. Preferably, all three layers are formed of thermoplastic polymer materials. In another aspect of the invention, the top layer exhibits a kinetic coefficient of friction with respect to a sample meant to emulate a typical shoe ~~outsole~~outsole (neoprene rubber, Shore A Durometer 60) of at least about 0.82.

Preferably, a major portion of the central layer is a polyolefin. More preferably, the polyolefin is either a polypropylene or a polyethylene. Most preferably, the polyolefin is high molecular weight polyethylene (HMPE) as herein defined. In an alternative embodiment, the central layer can be a styrene-acrylonitrile copolymer (SAN) or an acrylonitrile-butadiene-styrene (ABS) polymer blend.

Preferably, a major portion of the top layer is a thermoplastic elastomer, such as one of the ~~thermoplastic vulcanizates (TPVs) of proprietary composition~~compositions sold under the trademarks SANTOPRENE.RTM., GEOLAST.RTM. and VYRAM.RTM.. VYRAM.RTM.-~~thermoplastic vulcanizate (TPV)~~ is particularly preferred. In another embodiment, a major portion of the top layer can be an ABS polymer blend. Where ABS is used in both the top and central layers, it is preferred that the amount of the polybutadiene phase in the top layer be greater than the amount of this phase in the central layer.

It is further preferred that a major portion of the bottom layer likewise be a thermoplastic elastomer, and conveniently it can be, but does not have to be, of the same composition as the

major portion of the top layer.

Preferably one or more of the layers is actually a polymer blend, in which a minor portion is preselected for its ~~entanglement~~ entanglement compatibility with the adjacent layer(s). Thus, a minor portion of the top and bottom layers can consist of a polyolefin, while a minor portion of the central layer can consist of a thermoplastic elastomer. In each case, it is preferred that the minor portion be no more than about one part in four by weight of each layer, or a weight ratio of 1:3. Where all three layers are preselected to be ABS blends, the amount of polybutadiene preferably is decreased in the central layer relative to the top and bottom layers.

While the preferred embodiment of the vehicle floor cover consists of three integral layers, any one of the recited layers can in fact be made up of two or more sublayers, such that the total number of sublayers in the resultant mat or tray can exceed three.

In another embodiment, the thermoplastic elastomer constituent of the top, central and/or bottom layers described above can be replaced with a natural or synthetic rubber, including styrene butadiene rubber, butadiene rubber, acrylonitrile butadiene rubber (NBR) or ethylene propylene rubber (EPDM).

According to a related aspect of the invention, a vehicle floor cover is provided that has three layers bonded together, preferably by ~~entanglement~~ entanglement. Major portions of the top and bottom layer consist of thermoplastic elastomer(s). The top and bottom layers have compositions distinct from the central layer, which can be chosen for its relatively low expense. It is preferred that a major portion of the central layer be a polyolefin and that major portions of the top and bottom layers be one or more thermoplastic elastomers. The polyolefin may be selected from the group consisting of polypropylene and polyethylene, and preferably is a high molecular weight polyethylene (HMPE). The thermoplastic elastomer can, for example, be a ~~thermoplastic vulcanizate (TPV) sold under one of the marks~~ SANTOPRENE.RTM., GEOLAST-.RTM. or VYRAM.RTM., with VYRAM.RTM. ~~TPV~~ being particularly preferred. It is also preferred that each of the layers be a polymer blend, with a minor portion of each layer being chosen for its ~~entanglement~~ entanglement compatibility with adjacent layers. For example, the top and bottom layers can consist of a 3:1 weight ratio of VYRAM.RTM. ~~TPV~~/HMPE, and the central layer of a 3:1 weight ratio of HMPE/VYRAM.RTM. ~~TPV~~.

In an embodiment alternative to the one above, the top and bottom layers can consist of ABS polymer blends and the central layer can consist of SAN or an ABS in which the polybutadiene phase is present in a smaller concentration than in the top and bottom layers.

In yet another embodiment, the thermoplastic elastomer recited in this aspect of the invention may be replaced with a natural or synthetic rubber, such as styrene butadiene rubber (SBR), butadiene rubber, acrylonitrile butadiene rubber (NBR) or ethylene propylene rubber (EPDM).

In a further aspect of the invention, a vehicle floor tray or mat according to the invention is made of three layers, wherein a top layer and a bottom layer have composition(s) distinct from the central layer, and wherein at least one of the shear strength per cross-sectional area, tensile strength per cross-sectional area and stiffness per cross-sectional area is greater than any one of

the layers from which the tray or mat is composed. It has been found that a triextruded vehicle mat or floor tray according to the invention exhibits a tensile strength at yield, a tensile stress at break, a tensile modulus, a shear strength and a flexural modulus (stiffness) which are superior to either a polyolefin-dominated single extrusion or a thermoplastic elastomer-dominated single extrusion. The triextrusion tray demonstrates these enhanced physical properties while at the same time affording an enhanced coefficient of friction to the feet of the occupant and improved tactile properties. By presenting such a surface to the shoe of the driver or passenger, the footing of the driver or passenger will be more sure and comfortable.

In a further aspect of the invention, a vehicle foot well tray is provided as a part of a system that has the vehicle foot well as its other main component. The tray has a greatly enhanced conformance to the surface of the vehicle foot well for which it is provided. At least two upstanding walls of the tray, both extending from the tray floor to a top margin, conform to respective surfaces of the vehicle foot well such that at least within that one-third of the area of the outer surface of these upstanding walls of the tray which is adjacent the top margin, 90% of that top third area departs by no more than about one-eighth of an inch from the foot well surfaces to which they mate. These upstanding tray surfaces may be opposed surfaces or adjacent surfaces, and preferably are both. In a preferred embodiment, the tray departs from a door sill surface of the vehicle foot well, and/or a sill curve of the vehicle foot well, by about 0.025 inches. The upstanding sidewalls of the floor tray conform to the foot well surfaces which they cover, even where such foot well surfaces present both concave and convex surface elements.

In a still further aspect of the invention, a top margin of a vehicle floor tray is substantially coplanar on at least two upstanding sidewalls thereof. Preferably, the top margin of the tray is substantially coplanar through three or even four continuous upstanding sidewalls. This eases the design of the floor tray, increases hoop strength and assures that all upstanding surfaces of the vehicle foot well will receive adequate protection from muddy footwear. In a particularly preferred embodiment, the plane of the top margin is forwardly and upwardly tilted relative to a horizontal floor. This provides enhanced protection to the vehicle foot well precisely in the place where muddy footwear are likely to be, near the accelerator, brake and clutch pedals or the firewall. In a preferred embodiment, the tray is at least five inches deep at its deepest part.

In a further aspect of the invention, the above mentioned tight tolerances are made possible by a novel vehicle floor tray manufacturing method. In a first step according to the invention, points on a surface of the vehicle foot well are digitally measured with a coordinate measuring machine (CMM). These points are stored in a computer memory. A foot well surface is generated which includes these points, preferably by connecting linear groups of the points together by using B-splines, and lofting between the B-splines to create areal portions of the foot well surface. Using this typically complex three-dimensional, predominately concave surface, which may have several concavely and convexly curved portions, a corresponding substantially convex outer floor tray surface is built up such that in many regions, the distance between the outer surface of the tray and the surface of the foot well is no more than about one eighth of an inch, insuring a snug fit.

In one embodiment of the invention, a reservoir is incorporated into the tray floor as a collection and evaporation area for drip water from the feet and legs of the occupant. Combination

baffles/treads are provided in the reservoir to impede lateral movement of the collected fluid. Longitudinal and transverse portions of these baffles are joined together. Channels are cut into another portion of the central area of the tray to direct fluid to the reservoir, such that the bottom of the channels is beneath a general tray floor surface but above the bottom of the reservoir. ~~In a preferred driver's side embodiment, the channels are omitted from a portion of the floor tray upper surface to leave a blank space where the driver's heel will rest when operating the gas and brake pedals.~~ In a preferred driver's side embodiment, the channels are omitted from a portion of the floor tray upper surface to leave a blank space where the driver's heel will rest when operating the gas and brake pedals.

In a further aspect, a vehicle floor tray has a central panel for placement on the floor of a vehicle foot well, and at least first and second upstanding panels, joined to respective longitudinal and transverse margins of the central panel, for substantial conformance to side walls of the vehicle foot well. The tray is thermoformed from a sheet of polymer material having substantially uniform thickness, and this means that the components of the tray after thermoforming will have a substantially uniform thickness. A reservoir is formed in the central panel for collection of snow melt and other fluid. Multiple treads/baffles are disposed in the reservoir. The treads/baffles each have at least two opposed ends and are elongate. Each tread/baffle is hollow and has a width, in any horizontal direction, which is more than twice its thickness as measured from the top surface thereof to the nearest point on the bottom surface thereof. The treads/baffles are adapted to elevate the foot or shoe of the occupant out of the fluid collected by the reservoir. At the same time they are adapted to impede lateral movement of the collected fluid within the reservoir, as might occur when the vehicle turns, accelerates or brakes. The fluid is forced around ends of the treads/baffles in order to reach any remote portion of the reservoir. Since any portion of the reservoir is connected to any other portion of it, a large surface area of the reservoir is available for the collected fluid to spread out and evaporate.

BRIEF DESCRIPTION OF THE DRAWINGS

Further aspects of the invention and their advantages can be discerned in the following detailed description, in which like characters denote like parts and in which:

FIG. 1 is an isometric view of one embodiment of a vehicle floor tray according to the invention;

FIG. 2 is a top view of the floor tray illustrated in FIG. 1;

FIG. 3 is an isometric and transverse sectional view of the floor tray seen in FIGS. 1 and 2, the section taken substantially along line 3-3 of FIG. 2;

FIG. 4 is an isometric and longitudinal sectional view of the floor tray shown in FIGS. 1 and 2, the section taken substantially along line 4-4 of FIG. 2;

FIG. 5 is a side view of the tray illustrated in FIG. 1, taken from the outer side;

FIG. 6 is a highly magnified sectional view of a vehicle floor tray, showing triextruded layers;

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