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(54) Title: INSERTS FOR EXTRUDED MEMBERS

(57) Abstract: A structural reinforcement member comprises an extrusion member (10) having one or more walls and one or more voids (12) at least partially surrounded by the one or more walls of the extrusion member (10). An expandable activatable material (14) is located within the one or more voids (12), one or more secondary shaping operations are performed on the extrusion member (10), and the expandable activatable material (14) is activated to fill the one or more voids during an aging process, which provides additional strength while maintaining a light weight

INSERTS FOR EXTRUDED MEMBERS

FIELD OF THE INVENTION

[001] The present teachings relate generally to inserts for extruded members, and more particularly, activatable inserts for reinforcing extrusion members such as those made of aluminum.

BACKGROUND OF THE INVENTION

[002] Aluminum is a versatile material, as it can be extruded into custom shapes. This is particularly useful for automobiles and other transportation vehicles, as well as applications such as building and construction, because of its light weight and structural strength. Current technology uses structural reinforcements such as aluminum extrusions for maintaining or improving vehicle durability, stiffness, and crashworthiness. However, there is a continuing need for increased performance with reduced weight and costs, especially in the automotive industry.

[003] Activatable materials such as heat-expandable foams and adhesives are often applied to the outer walls of or integrated into structural reinforcements. Such foams and adhesives expand to fill the gaps between the structural reinforcements and/or within cavities of a vehicle. However, with extruded members, there may be hollow areas or voids where the adhesive or foam, even upon expansion, cannot reach. Activation and curing of the adhesive or foam generally takes place during heating in a bake oven associated with a step of coating a vehicle, such as upon painting. The installation of these structural reinforcements is thus limited to original equipment manufacturers (OEM) or other large scale manufacturers that have the paint ovens to activate the expandable adhesive, which can be inconvenient when parts must later be replaced, such as those damaged from a collision, to restore the structural integrity and safety of the vehicles.

[004] There is thus a need in the industry to provide additional reinforcement of extrusion members that increases load carrying capability and improves noise, vibration, and harshness (NVH) characteristics while decreasing or maintaining a light weight. It is

also desirable that these structural reinforcements be capable of installation in vehicles outside of an OEM or other large scale manufacturer, such as in a trim or body shop.

SUMMARY OF THE INVENTION

[005] The present teachings meet one or more of the above needs by allowing for increased performance of a structural reinforcement while also expanding capability to allow installation to occur in a trim or body shop, for example, without requiring installation at an OEM or other large scale manufacturing facility (e.g., a facility having a paint bake oven).

[006] The present teachings may include any one, all or combination of the following features. The teachings may include a structural reinforcement member comprising an extrusion member having one or more walls, with the one or more walls at least partially surrounding one or more voids. The extrusion member may comprise aluminum or another metal or metal alloy. An expandable activatable material may be located within the one or more voids (prior to any expansion), and the expandable activatable material may be activated to fill the one or more voids (and possibly areas adjacent the one or more voids) and cure during an aging process of the extrusion member, such as by heat aging. The expandable activatable material may be heat activated, and/or the expandable activatable material may have adhesive properties to adhere to the one or more walls surrounding the one of more voids of the extrusion member upon expansion. The expandable activatable material may be dry and not tacky to the touch at room temperature. The expandable activatable material may comprise an epoxy-based resin having foamable characteristics. The structural reinforcement member may undergo one or more secondary shaping operations, which may occur prior to the activation of the expandable activatable material, so that the structural reinforcement member may be shaped to be located within a desired area, such as a cavity. For example, the structural reinforcement member may be for use in a vehicle, such as in a vehicle cavity.

[007] The present teachings also may involve a process for providing structural reinforcement. The process may include any, all, or a combination of any of the following steps and features, and any order of the following steps are within the scope of this disclosure. The process may include extruding a metal member having one or more walls with one or more voids at least partially surrounded by the one or more walls of the metal member. The metal member may comprise aluminum. An expandable activatable

material may be inserted into the one or more voids. The expandable activatable material may be inserted into the one or more voids in solid form or in liquid form. The expandable activatable material may be heat activated and/or may adhere to the one or more walls of the metal member surrounding the one or more voids upon expansion (e.g., curing). The expandable activatable material may comprise an epoxy-based resin having foamable characteristics. The expandable activatable material may be dry, not tacky to the touch, at room temperature. One or more secondary shaping operations may be performed to shape the metal member to a desired shape. These secondary shaping operations may include stretching, crimping, bending, forming, cutting, the like, or any combination thereof. The metal member may be aged to provide additional strength. The aging step may activate the expandable activatable material to fill the one or more voids and cure. The aging step may include applying heat to the metal member at a temperature sufficient to activate the expandable activatable material. For example, the heat may be applied at a temperature of about 400°F or less. The process may further include a step of installing the structural reinforcement within a cavity of a vehicle. This installing step may be performed by an OEM or other large scale manufacturer, or, alternately, it may be performed by a trim or body shop or any location remote from the OEM or other large scale manufacturer. Such installation may occur prior to any activation of the expandable activatable material.

[008] These improvements provide reinforcement to extrusion members, such as those comprising aluminum, which increases the load carrying capability of the extrusion members while still maintaining light weight. The expandable material may act as a bonding agent that holds together and stiffens load-bearing parts and provides a damping effect, which reduces the transmission of vibration to the body structure of the vehicle into which it is installed.

DESCRIPTION OF THE DRAWINGS

[009] Figure 1 illustrates an exemplary extrusion member with adhesive in a pre-activated state located within a void of the exemplary extrusion member.

[0010] Figure 2 illustrates the exemplary extrusion member of Figure 1 with the adhesive in a post-activated state.

[0011] Figure 3 is a flow diagram of an exemplary process for forming a reinforced extrusion member in accordance with the teachings herein.

DETAILED DESCRIPTION

[0012] This application claims the benefit of the filing date of U.S. Provisional Application Serial No. 61/993,714, filed May 15, 2014. The entirety of the contents of that application is hereby incorporated by reference herein for all purposes.

[0013] The explanations and illustrations presented herein are intended to acquaint others skilled in the art with the invention, its principles, and its practical application. Those skilled in the art may adapt and apply the invention in its numerous forms, as may be best suited to the requirements of a particular use. Accordingly, the specific embodiments of the present invention as set forth are not intended as being exhaustive or limiting of the invention. The scope of the invention should, therefore, be determined not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. The disclosures of all articles and references, including patent applications and publications, are incorporated by reference for all purposes. Other combinations are also possible as will be gleaned from the following claims, which are also hereby incorporated by reference into this written description.

[0014] The present teachings contemplate using an insert comprising activatable material inside voids in extrusion members to provide additional support; reinforcement; load carrying capability; stiffness; improved noise, vibration, and harshness (NVH) characteristics; combinations thereof and the like. Extrusion members are versatile and can be used in applications such as automotive, marine, aerospace, military, building and construction, lighting, electronics, consumer durables, and many other engineered products. The extrusion members are preferably made of metal and/or metal alloys, though other materials, such as plastics, are also possible. Preferably, the extrusions are lightweight, non-magnetic, corrosion resistant, tough, easily machined or bent, readily recycled, non-toxic, and the like, or any combination thereof. In one embodiment, the extrusion members may comprise aluminum, as aluminum is capable of being extruded into precise shapes. Aluminum may be used in its pure form, or it may be blended with magnesium, copper, manganese, silicon, zinc, or other materials, or combinations thereof to create alloys with desired properties. For example, the blend may offer increased strength, conductivity, corrosion resistance, and/or other desired properties.

[0015] Extrusion members are shaped pieces of metal, such as aluminum or aluminum alloy, produced by heating metal blocks and pushing them through a die to create a particular shape or cross-section. From extrusion or other secondary shaping processes, the extrusion members may be formed into any desired shape and may include, for example, angles, channels, flat bars, T-bars and Z-bars, I-beams, square or rectangular tubes, the like, or any combination thereof.

[0016] Extrusion of members, such as those comprising aluminum or aluminum alloy, allows a manufacturer to create a desired shape for a particular application (e.g., based on desired tolerances, structural requirements, aesthetic requirements, and the like). Extruded members may take a variety of shapes, preferably having a hollow or semi-hollow cross-section. The hollow or semi-hollow cross-section may entirely or partially enclose a void, and the void itself may have any desired shape. An extruded member may also have two or more voids, such as a multi-celled extrusion (e.g., having inner reinforcements designed into the part to increase strength and rigidity and provide resistance to twisting). Each void or some voids may have a different shape or each void or some voids may have the same shape.

[0017] The insert of the present teachings preferably is inserted into the one or more voids of the extrusion members and also preferably comprises an activatable material. The insert may also include a carrier upon which the activatable material is located. Alternatively the insert may be substantially free of any carrier. The activatable material (e.g., after activation) may assist in providing various properties including structural reinforcement, sealing, acoustical damping properties, combinations thereof and the like. For example, the activatable material may act as an adhesive which is a bonding agent that holds together and stiffens load-bearing parts and provides a damping effect, which reduces the transmission of vibration through the body structure of a vehicle. As used herein, the phrase activatable material includes any material that may be activated to cure (e.g., thermoset), and optionally melt, flow, expand, foam, or a combination thereof by an ambient condition or upon exposure to a particular stimulus. The material may cure and may, in addition, expand, foam, flow, melt, a combination thereof, or the like, upon exposure to a condition such as heat, pressure, chemical exposure, combinations thereof, or the like.

[0018] The activatable material may be activated in any suitable manner. In a preferred embodiment, the activatable material is preferably a heat activated adhesive. In this embodiment, the adhesive is preferably foamed by the application of heat and

more preferably, the adhesive foams and develops adhesive properties during the same heating cycle. In this way, the extruded member with the insert in place may be heated within the extruded member in which it is located. Alternatively, the adhesive may be activated at ambient temperature. In this embodiment, it is preferred that the insert be stored at a temperature below that at which the adhesive is activated. In this way, during storage, the adhesive will preferably be inactive and/or dry to the touch. Typically, storage temperatures from -18°C to 10°C may be used.

[0019] Where the material is expandable, the teachings herein include inserting the activatable material into the aluminum extrusion in an unexpanded or partially expanded state and activating the material for expanding (e.g., foaming) to a volume greater than its volume in the unexpanded or partially expanded state (e.g., at least 5% greater, at least 50% greater, at least 200% greater or even at least 1000% or at least 2000%). It is also typically preferred, at least for reinforcement applications, that the volumetric expansion is such that the expanded volume is less than 400%, more typically less than 300%, possibly less than about 200% or even less than about 100% relative to the original unexpanded volume. Preferably, the material expands to contact and/or adhere to the surrounding walls of the extruded member.

[0020] Although not essential, the adhesive may be dry to the touch and/or non-tacky at room temperature. Preferably, it is a material that can be heat activated to both expand and develop adhesive properties to adhere to the inner walls of the extrusion member surrounding the void. Typically, the activatable material, upon activation, will wet and bond to the inner surface of the extrusion member and it may be a thermoplastic, a thermoset or a blend thereof. The material may be a structural foam that cures to a rigid structure, such as an epoxy-containing material, an ethylene-containing polymer, an acetate or acrylate containing polymer, or a mixture thereof, which when compounded with appropriate ingredients (e.g., a blowing agent, curing agent, filler, or combination thereof), typically expands, cures or both in a reliable and predictable manner upon the application of heat or another activation stimulus. Therefore, an exemplary material may be a heat-activated and/or epoxy-based resin having foamable characteristics. After curing, the material may become a thermoset material that is fixed and incapable of any substantial flow.

[0021] The activatable or expandable material typically includes one or more polymeric materials, which may include a variety of different polymers, such as thermoplastics, elastomers, plastomers, and combinations thereof, or the like. For

example, and without limitation, polymers that might be appropriately incorporated into the polymeric admixture include halogenated polymers, polycarbonates, polyketones, urethanes, polyesters, silanes, sulfones, allyls, olefins, styrenes, acrylates, methacrylates (e.g., ethylene methyl acrylate polymer), epoxies, silicones, phenolics, rubbers, polyphenylene oxides, terephthalates, acetates (e.g., EVA), or mixtures thereof. Other potential polymeric materials may be or may include, without limitation, polyolefin (e.g., polyethylene, polypropylene) polystyrene, polyacrylate, poly(ethylene oxide), poly(ethyleneimine), polyester, polyurethane, polysiloxane, polyether, polyphosphazine, polyamide, polyimide, polyisobutylene, polyacrylonitrile, polyvinyl chloride, poly(methyl methacrylate), polyvinyl acetate, poly(vinylidene chloride), polytetrafluoroethylene, polyisoprene, polyacrylamide, polyacrylic acid, polymethacrylate.

[0022] The activatable material may include an epoxy resin, which includes any of the conventional dimeric, oligomeric or polymeric epoxy materials containing at least one epoxy functional group. The polymer-based materials may be epoxy containing materials having one or more oxirane rings polymerizable by a ring opening reaction. The epoxy may be aliphatic, cycloaliphatic, aromatic, or the like. The epoxy may be supplied as a solid (e.g., a pellets, chunks, pieces or the like) or a liquid (e.g., an epoxy resin). The epoxy may include an ethylene copolymer or terpolymer that may possess an alpha-olefin. As a copolymer or terpolymer, the polymer comprises two or three different monomers, i.e., small molecules with high chemical reactivity that are capable of linking up with similar molecules. Preferably, an epoxy resin is added to the activatable material to increase adhesion properties of the material. One exemplary epoxy resin may be a phenolic resin, which may be a novalac type or other type of resin. Other preferred epoxy containing materials may include a bisphenol-A epichlorohydrin ether polymer, or a bisphenol-A epoxy resin which may be modified with butadiene or another polymeric additive.

[0023] Activatable materials of the present teachings can include a substantial amount of elastomeric or rubber material, which can be one elastomer or a mixture of several different elastomers. Rubbers and elastomers suitable for the elastomeric material include, without limitation, natural rubber, styrene-butadiene rubber, polyisoprene, polyisobutylene, polybutadiene, isoprene-butadiene copolymer, neoprene, nitrile rubber (e.g., a butyl nitrile, such as carboxy-terminated butyl nitrile), butyl rubber, polysulfide elastomer, acrylic elastomer, acrylonitrile elastomers, silicone rubber, polysiloxanes, polyester rubber, diisocyanate-linked condensation elastomer, EPDM

(ethylene-propylene die[eta]e monomer rubbers), chlorosulphonated polyethylene, fluorinated hydrocarbons, and the like.

[0024] An elastomer-containing adduct can also be employed in the activatable material of the present teachings such as an epoxy/elastomer adduct. The elastomer-containing adduct, when added to the activatable material, preferably is added to modify structural properties of the material such as strength, toughness, stiffness, flexural modulus, or the like. The elastomer compound may be a thermosetting or other elastomer. Exemplary elastomers include, without limitation, natural rubber, styrene-butadiene rubber, polyisoprene, polyisobutylene, polybutadiene, isoprene-butadiene copolymer, neoprene, nitrile rubber (e.g., a butyl nitrite, such as carboxy-terminated butyl nitrile), butyl rubber, polysulfide elastomer, acrylic elastomer, acrylonitrile elastomers, silicone rubber, polysiloxanes, polyester rubber, diisocyanate-linked condensation elastomer, EPDM (ethylene-propylene diene rubbers), chlorosulphonated polyethylene, fluorinated hydrocarbons and the like. In one embodiment, recycled tire rubber can be employed.

[0025] One or more blowing agents may be added to the activatable material. Such blowing agents assist in forming cellular or foamed activated materials, which typically have a lower density and/or weight. The blowing agent may be a physical blowing agent or a chemical blowing agent. For example, the blowing agent may be a thermoplastic encapsulated solvent that expands upon exposure to a condition such as heat. Alternatively, the blowing agent may chemically react to liberate gas upon exposure to a condition such as heat or humidity or upon exposure to another chemical reactant. The blowing agent may include one or more nitrogen containing groups such as amides, amines, and the like. Examples of suitable blowing agents include azodicarbonamide, dinitrosopentamethylenetetramine, 4,4j-oxy-bis-(benzenesulphonylhydrazide), trihydrazinotriazine and N,Nj-dimethyl-N,Nj-dinitrosoterephthalamide.

[0026] An accelerator for the blowing agents may also be provided in the activatable material. Various accelerators may be used to increase the rate at which the blowing agents form inert gases. One preferred blowing agent accelerator is a metal salt, or is an oxide (e.g., a metal oxide, such as zinc oxide). Other preferred accelerators include modified and unmodified thiazoles or imidazoles, ureas or the like. Amounts of blowing agents and blowing agent accelerators can vary widely within the activatable material depending upon the cellular structure desired, the desired amount of

expansion of the expandable material, the desired rate of expansion and the like.

[0027] One or more curing agents and/or curing agent accelerators may be added to the activatable material. Amounts of curing agents and curing agent accelerators can also vary widely within the activatable material depending upon the type of cellular structure desired, the desired amount of expansion of the activatable material, the desired rate of expansion, the desired structural properties, of the activatable material and the like.

[0028] Typically, the curing agents assist the activatable material in curing by crosslinking of the polymers, epoxy resins, or both. It can also be desirable for the curing agents to assist in thermosetting the activatable material. Useful classes of curing agents are materials selected from aliphatic or aromatic amines or their respective adducts, amidoamines, polyamides, cycloaliphatic amines (e.g., anhydrides, polycarboxylic polyesters, isocyanates, phenol-based resins (such as phenol or cresol novolak resins), copolymers such as those of phenol terpene, polyvinyl phenol, or bisphenol-A formaldehyde copolymers, bishydroxyphenyl alkanes or the like), sulfur or mixtures thereof. Particular preferred curing agents include modified and unmodified polyamines or polyamides such as triethylenetetramine, diethylenetriamine, tetraethylenepentamine, cyanoguanidine, dicyandiamides, and the like. An accelerator for the curing agents (e.g., a modified or unmodified urea such as methylene diphenyl bis urea, an imidazole or a combination thereof) may also be provided for preparing the activatable material. Other examples of curing agent accelerators include, without limitation, metal carbamates (e.g., copper dimethyl dithio carbamate, zinc dibutyl dithio carbamate, combinations thereof, or the like), disulfides (e.g., dibenzothiazole disulfide), or the like.

[0029] In one embodiment, the activatable material may include a first curing agent and, optionally, a first curing agent accelerator and a second curing agent and, optionally, a second curing agent accelerator, any or all of which may be latent. The first curing agent and/or accelerator are typically designed to partially cure the activatable material during processing (e.g., processing, mixing, shaping or combination thereof) of the activatable material with the desired self-supporting properties. The second curing agent and/or accelerator will then typically be latent such that they cure the activatable material upon exposure to a condition such as heat, moisture or the like.

[0030] As one preferred example of this embodiment, the second curing agent and/or accelerator are latent such that one or both of them cure the polymeric materials

of the expandable material at a second temperature or activation temperature or temperature range. However, the first curing agent and/or accelerator may be also latent, but either or both of them partially cure the expandable material upon exposure to a first elevated temperature that is below the second temperature or activation temperature. The first temperature and partial cure will typically be experienced during material mixing, shaping, or both. For example, the first temperature and partial cure can be experienced in an extruder that is mixing the ingredients of the activatable material and extruding the activatable material through a die into a particular shape. As another example, the first temperature and partial cure can be experienced in a molding machine (e.g., injection molding, blow molding, compression molding) that is shaping and, optionally, mixing the ingredients of the expandable material.

[0031] The second temperature or activation temperature and substantially full cure can then occur at a temperature experienced during processing of the extrusion member into which the activatable material has been inserted. For example, when the aluminum extrusion member goes through the aging process, the activatable material can additionally expand (e.g., foam) as well as cure.

[0032] The activatable material may also include one or more fillers, including but not limited to particulated materials (e.g., powder), beads, microspheres, or the like. Preferably, the filler includes a relatively low-density material that is generally non-reactive with the other components present in the activatable material.

[0033] Examples of filler include silica, diatomaceous earth, glass, clay, talc, pigments, colorants, glass beads or bubbles, glass, carbon ceramic fibers, antioxidants, and the like. Such fillers, particularly clays, can assist the activatable material in leveling itself during flow of the material. The clays that may be used as fillers may include clays from the kaolinite, illite, chloritem, smecitite or sepiolite groups, which may be calcined. Examples of suitable fillers include, without limitation, talc, vermiculite, pyrophyllite, sauconite, saponite, nontronite, montmorillonite or mixtures thereof. The clays may also include minor amounts of other ingredients such as carbonates, feldspars, micas, and quartz. The fillers may also include ammonium chlorides such as dimethyl ammonium chloride and dimethyl benzyl ammonium chloride. Titanium dioxide might also be employed. In one preferred embodiment, one or more mineral or stone type fillers such as calcium carbonate, sodium carbonate or the like may be used as fillers. In another preferred embodiment, silicate minerals such as mica may be used as fillers. It has been found that, in addition to performing the normal functions of a filler, silicate minerals and

mica in particular improved the impact resistance of the cured activatable material.

[0034] One of the fillers or other components of the material may be thixotropic for assisting in controlling flow of the material as well as properties such as tensile, compressive or shear strength. Such thixotropic fillers can additionally provide self-supporting characteristics to the activatable material. Examples of thixotropic fillers include, without limitation, silica, calcium carbonate, clays, aramid fiber or pulp or others. One preferred thixotropic filler is synthetic amorphous precipitated silicon dioxide.

[0035] The activatable material may also include one or more fire retardants. Useful flame retardants for the activatable material include halogenated polymers, other halogenated materials, materials (e.g., polymers) including phosphorous, bromine, chlorine, bromine oxide, combinations thereof or the like. Exemplary flame retardants include, without limitation, chloroalkyl phosphate, dimethyl methylphosphonate, bromine-phosphorus compounds, ammonium polyphosphate, neopentylbromide polyether, brominated polyether, antimony oxide, calcium metaborate, chlorinated paraffin, brominated toluene, hexabromobenzene, antimony trioxide, graphite (e.g., expandable graphite), combinations thereof or the like.

[0036] Other additives, agents or performance modifiers may also be included in the expandable material as desired, including but not limited to a UV resistant agent, a flame retardant, an impact modifier, a heat stabilizer, a UV photoinitiator, a colorant, a processing aid, a lubricant, a reinforcement (e.g., chopped or continuous glass, ceramic, aramid, carbon fiber or the like).

[0037] The activatable material may also include an adhesion promoter, including but not limited to epoxy materials, acrylates, hydrocarbon resins or the like. Activatable materials may also include a processing oil or a mixture of multiple oils.

[0038] In a preferred embodiment, the activatable material is inserted as an insert into the extrusion member during assembling and processing the structural member. The process may include the following steps. Shaping the extrusion member can use any process known in the art. For example, the extrusion member can be shaped by first heating blocks, or billets, preferably of aluminum or aluminum alloy, to soften the metal. The heated metal is generally coated with a release agent, film or lubricant and sent through a hydraulic or mechanical press, which gradually pushes the heated material through a die to create a straight extrusion with a desired cross-sectional shape. The heat applied to the metal is dependent upon the metal and/or alloys used, as these are processed at different temperatures. The extrusion may be

cooled, such as with water or air, upon exiting the die.

[0039] The activatable material may be inserted into one or more voids or hollow spaces within the straight extrusion. The activatable material may be solid, liquid, molded, dry, non-tacky to the touch, or combination thereof, and may fit within the void or hollow space. Alternatively, the activatable material may be introduced into the void or hollow space by a mini-applicator or other applicator (e.g., for use with liquid activatable material).

[0040] After extrusion, the extrusion member may undergo secondary shaping processes, such as stretching, crimping, bending, forming, cutting to a desired length, and the like, to fit the area being reinforced. It is also possible that the activatable material can be inserted into the extrusion after any or all of the secondary shaping processes (e.g., the straight extrusion may be stretched or cut to a desired length prior to inserting the activatable material).

[0041] The extrusion members are then aged to increase hardness and temper the material (e.g., to take the aluminum material from a T4 temper designation to a T6 temper designation). The aging process may include treatment of a metal or metal alloy at elevated temperatures so as to accelerate the changes in the properties of the metal or metal alloy as a result of a casting and forging process. The aging process may take place at room temperature, or more preferably, in an aging oven. Preferably, the aging process is a heat aging process performed at a temperature about 400°F or less for a period of about 1 hour or more and about 12 hours or less. During the aging process, the activatable material is preferably activated, thereby causing the activatable material to expand to at least partially fill the void or hollow areas within the extrusion material, and cured.

[0042] Turning now to the figures, Figure 1 shows an exemplary extrusion member 10 having a hollow area or void 12. The activatable material 14 is located within the void 12 prior to expansion. Figure 2 shows the exemplary extrusion member 10 of Figure 1 after the activatable material 14 has been activated to expand and at least partially fill the void (see Figure 1). This provides stiffness for load-bearing parts and a damping effect to reduce the transmission of vibrations through the body structure while maintaining a light weight.

[0043] Figure 3 shows an exemplary process for creating the extruded members with activatable material inserts. These steps are exemplary, and are not to serve as limiting in the order of performing these steps. The steps herein performed in any order

or performed multiple times are within the scope of these teachings. In this exemplary process, step 310 involves creating an aluminum extrusion having one or more voids. Aluminum is preferred as it may be used to extrude and bend into precision shapes, though other metallic extrusions are possible. The extrusion may be created using any metallic extrusion method known in the art.

[0044] Following formation of the extrusion, step 320 involves inserting an activatable material in the one or more voids of the aluminum extrusion. Preferably the activatable material is heat-activated, foamable, capable of expansion, adhesive, the like, or any combination thereof. Preferably, the activatable material has not yet been activated or not yet been fully activated upon insertion in the one or more voids. The activatable material may be inserted in solid form, liquid form, or combination thereof.

[0045] Step 330 involves performing one or more secondary shaping operations to shape the aluminum extrusion. Aluminum extrusions may require shaping to a desired shape or length, such as one that generally matches the shape of a cavity into which the extrusion will be inserted. These shaping operations may include crimping, bending, forming, stretching, cutting, the like, or a combination thereof. Some of these secondary shaping operations may be performed prior to performing step 320. For example, it may be desirable to stretch and/or cut a straight extrusion to a desired length before inserting activatable material in the one or more voids.

[0046] Step 340 involves aging the aluminum extrusion. This aging step may be a heat aging step, where heat is applied to the aluminum extrusion for a desired length of time to thermally treat the extrusion and provide additional strength (e.g., to bring the aluminum from a T4 to a T6 temper designation). Preferably, the activatable material is heat-activated and will expand to at least partially fill the one or more voids, will adhere to the walls surrounding the one or more voids, will cure, or combination thereof.

[0047] Step 350 involves installing the shaped aluminum extrusion into the cavity of a vehicle. The activatable material within the shaped aluminum extrusion preferably acts as a bonding agent that holds together and stiffens load-bearing parts and provides a damping effect, which reduces the transmission of vibration through the body structure. As the activatable material has preferably already been expanded and cured, the extrusions can be installed outside of an OEM or other large scale manufacturing facility. For example, when parts are damaged in a vehicle from a collision, they are often replaced to restore the structural integrity and safety of the vehicles, and these extrusions can be installed in a vehicle in a trim or body shop.

[0048] As to all of the foregoing general teachings, as used herein, unless otherwise stated, the teachings envision that any member of a genus (list) may be excluded from the genus; and/or any member of a Markush grouping may be excluded from the grouping.

[0049] Unless otherwise stated, any numerical values recited herein include all values from the lower value to the upper value in increments of one unit provided that there is a separation of at least 2 units between any lower value and any higher value. As an example, if it is stated that the amount of a component, a property, or a value of a process variable such as, for example, temperature, pressure, time and the like is, for example, from 1 to 90, preferably from 20 to 80, more preferably from 30 to 70, it is intended that intermediate range values such as (for example, 15 to 85, 22 to 68, 43 to 51, 30 to 32 etc.) are within the teachings of this specification. Likewise, individual intermediate values are also within the present teachings. For values which are less than one, one unit is considered to be 0.0001, 0.001, 0.01 or 0.1 as appropriate. These are only examples of what is specifically intended and all possible combinations of numerical values between the lowest value and the highest value enumerated are to be considered to be expressly stated in this application in a similar manner. As can be seen, the teaching of amounts expressed as "parts by weight" herein also contemplates the same ranges expressed in terms of percent by weight. Thus, an expression in the Detailed Description of the Invention of a range in terms of at "'x' parts by weight of the resulting polymeric blend composition" also contemplates a teaching of ranges of same recited amount of "x" in percent by weight of the resulting polymeric blend composition."

[0050] Unless otherwise stated, all ranges include both endpoints and all numbers between the endpoints. The use of "about" or "approximately" in connection with a range applies to both ends of the range. Thus, "about 20 to 30" is intended to cover "about 20 to about 30", inclusive of at least the specified endpoints. Concentrations of ingredients identified in Tables herein may vary ±10%, or even 20% or more and remain within the teachings.

[0051] The disclosures of all articles and references, including patent applications and publications, are incorporated by reference for all purposes. The term "consisting essentially of" to describe a combination shall include the elements, ingredients, components or steps identified, and such other elements ingredients, components or steps that do not materially affect the basic and novel characteristics of the combination. The use of the terms "comprising" or "including" to describe

combinations of elements, ingredients, components or steps herein also contemplates embodiments that consist essentially of, or even consist of the elements, ingredients, components or steps. Plural elements, ingredients, components or steps can be provided by a single integrated element, ingredient, component or step. Alternatively, a single integrated element, ingredient, component or step might be divided into separate plural elements, ingredients, components or steps. The disclosure of "a" or "one" to describe an element, ingredient, component or step is not intended to foreclose additional elements, ingredients, components or steps. All references herein to elements or metals belonging to a certain Group refer to the Periodic Table of the Elements published and copyrighted by CRC Press, Inc., 1989. Any reference to the Group or Groups shall be to the Group or Groups as reflected in this Periodic Table of the Elements using the IUPAC system for numbering groups.

[0052] It is understood that the above description is intended to be illustrative and not restrictive. Many embodiments as well as many applications besides the examples provided will be apparent to those of skill in the art upon reading the above description. The scope of the invention should, therefore, be determined not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. The disclosures of all articles and references, including patent applications and publications, are incorporated by reference for all purposes. The omission in the following claims of any aspect of subject matter that is disclosed herein is not a disclaimer of such subject matter, nor should it be regarded that the inventors did not consider such subject matter to be part of the disclosed inventive subject matter.

CLAIMS

What is claimed is:

Claim 1. A structural reinforcement member comprising:

i) an extrusion member having one or more walls and one or more voids at least partially surrounded by the one or more walls of the extrusion member;

ii) an expandable activatable material located within the one or more voids,

wherein the expandable activatable material is activated to fill the one or more voids and cure during an aging process.

Claim 2. The structural reinforcement member of claim 1, wherein the extrusion member comprises aluminum.

Claim 3. The structural reinforcement member of claim 1 or 2, wherein the expandable activatable material is heat activated.

Claim 4. The structural reinforcement member of any of the preceding claims, wherein the expandable activatable material adheres to the one or more walls of the extrusion member upon expansion.

Claim 5. The structural reinforcement member of any of the preceding claims, wherein the expandable activatable material is an expandable adhesive that is dry to the touch, at room temperature.

Claim 6. The structural reinforcement member of any of the preceding claims, wherein the expandable activatable material comprises an epoxy-based resin having foamable characteristics.

Claim 7. The structural reinforcement member of any of the preceding claims, wherein the structural reinforcement member undergoes one or more secondary shaping operations prior to the activation of the expandable activatable material.

Claim 8. The structural reinforcement member of any of the preceding claims, wherein the structural reinforcement member is for use in a vehicle.

Claim 9. A process for providing structural reinforcement comprising:

i) extruding a metal member having one or more walls and one or more voids at least partially surrounded by the one or more walls of the metal member;

ii) inserting an expandable activatable material into the one or more voids;

iii) performing one or more secondary shaping operations to shape the metal member; and

iv) aging the metal member for additional strength properties;

wherein the aging step activates the expandable activatable material to fill the one or more voids and cures the expandable activatable material.

Claim 10. The process according to claim 9, wherein the metal member comprises aluminum.

Claim 11. The process according to claim 9 or 10, wherein the expandable activatable material is heat activated.

Claim 12. The process according to any of claims 9 to 11, including adhering the expandable activatable material to the one or more walls of the metal member surrounding the one or more voids upon expansion.

Claim 13. The process according to any of claims 9 to 12, wherein the expandable activatable material comprises an epoxy-based resin having foamable characteristics.

Claim 14. The process according to any of claims 9 to 13, wherein the expandable activatable material is inserted into the one or more voids in solid form.

Claim 15. The process according to any of claims 9 to 13, wherein the expandable activatable material is inserted into the one or more voids in liquid form.

Claim 16. The process according to any of claims 9 to 15, wherein the expandable activatable material is dry to the touch, at room temperature.

Claim 17. The process according to any of claims 9 to 16, wherein the one or more secondary shaping procedures include stretching, crimping, bending, forming, cutting, or combination thereof.

Claim 18. The process according to any of claims 9 to 17, wherein the aging step includes applying heat to the metal member at about 400°F or less.

Claim 19. The process according to any of claims 9 to 18, further comprising the step of installing the structural reinforcement within a cavity of a vehicle.

Claim 20. The process according to claim 19, wherein the installing step is performed in a trim or body shop.

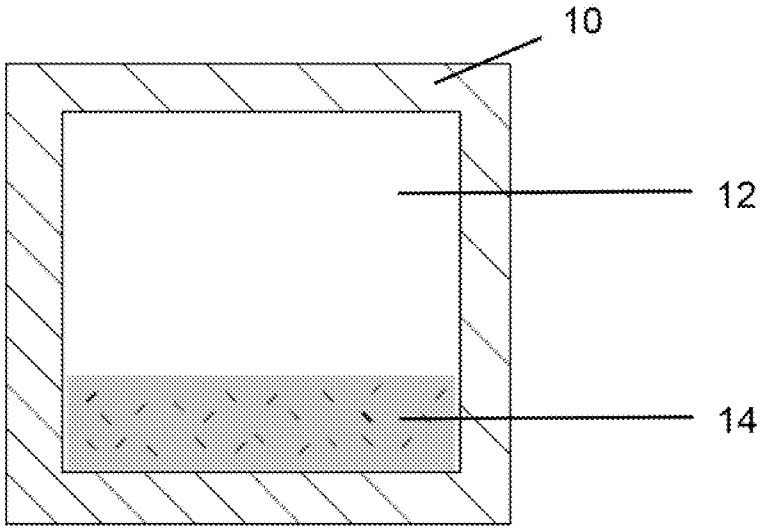


FIG. 1

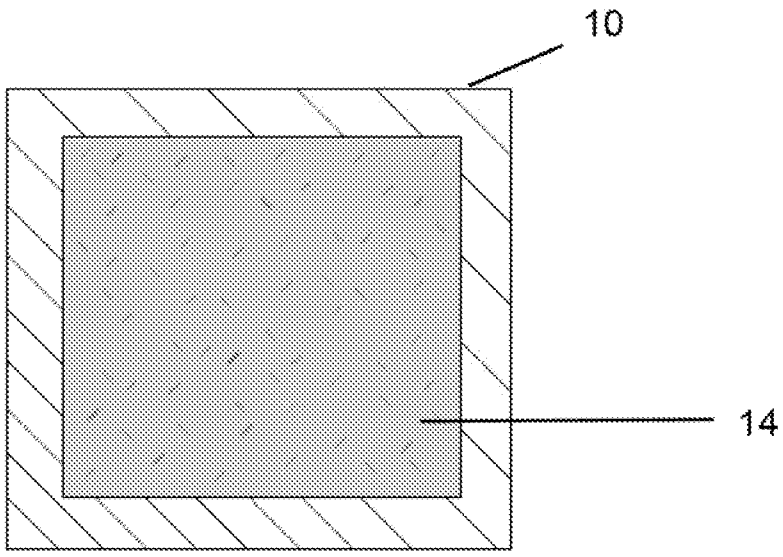
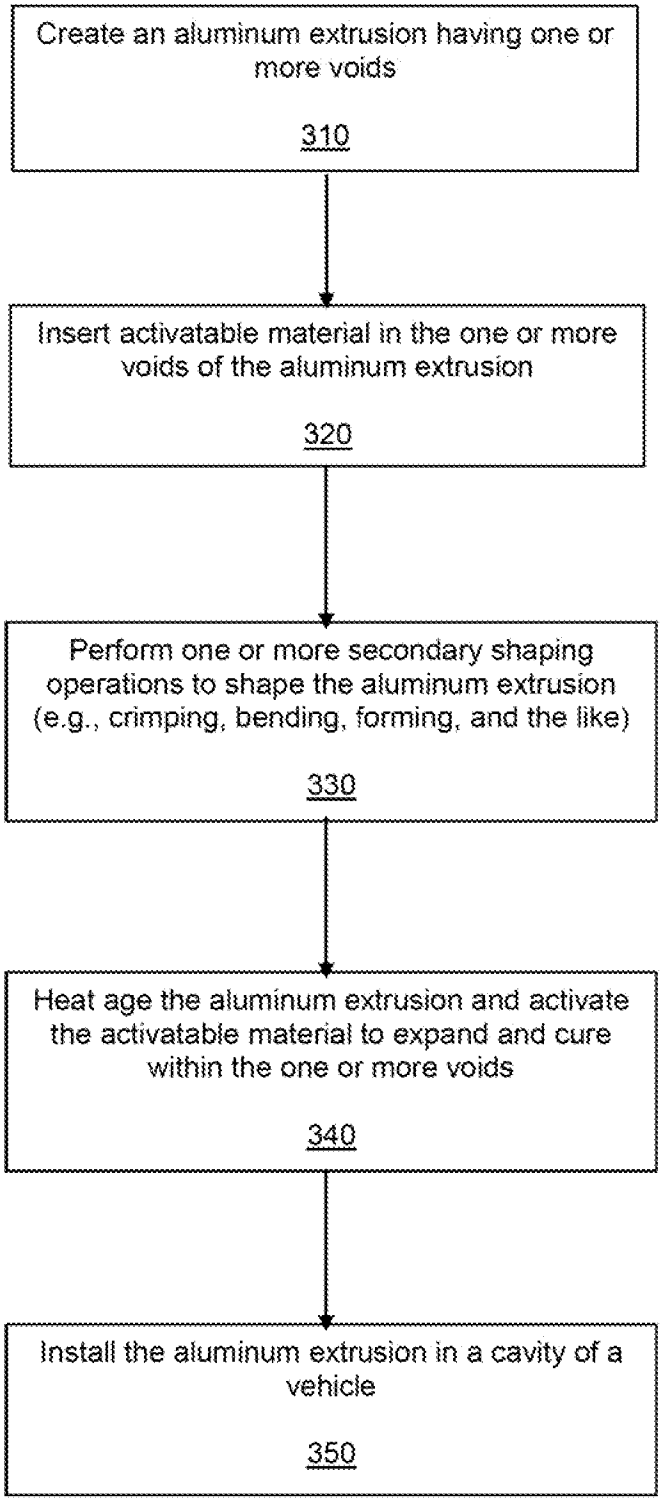


FIG. 2

FIG. 3


Create an aluminum extrusion having one or more voids
310
Insert activatable material in the one or more voids of the aluminum extrusion
320
Perform one or more secondary shaping operations to shape the aluminum extrusion (e.g., crimping, bending, forming, and the like)
330
Heat age the aluminum extrusion and activate the activatable material to expand and cure within the one or more voids
340
Install the aluminum extrusion in a cavity of a vehicle
350

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/031004

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C44/18 B60R13/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C B60R B62D B29K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 2015	27/08/2015

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No
PCT/US2015/031004

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