Material Selection and Manufacturing of Halogen-Based Headlamp for Two-Wheeler Vehicle Technologies

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ABSTRACT: *In the plastic industry, distinctive handling hardware like expulsion, infusion trim, Calendaring, and thermoforming are utilized to fabricate various products. This equipment is fundamentally the improvement of Standard Injection Molding which Injection Molding is significant. This procedure is utilized for the assembling of the hollow section part and the part with thin wall thickness. This research aimed to develop a halogen-based Headlamp for a two-wheeler vehicle. The essential objective of an automotive headlight is to enhance safety and protection in low light and poor climate conditions. It is the first time that a halogen-based headlamp for a two-wheeler vehicle has been created for the first time in Pakistan. The product in our project consists of three major components, reflector, halogen bulb, and lens. Material selection and processing were the two major tasks in this project. The product was manufactured through injection molding, a high vacuum metallization process, and then finally assembling of parts. To determine the quality of the product, six tests were performed according to the Japanese standard JIS-D5500.*

KEYWORDS: *Plastic industry; Headlamp; Gas assist injection molding; Moldflow polymer; Two-wheeler vehicle, Dust; Intensity.*

INTRODUCTION

Today is hard to envision a vehicle or any sort of vehicle without headlights. In the case of passing through rain, fog, or the dark of night, we regularly underestimate our headlamps that is, until something turns out badly. A basic headlight lens restoration pack today could offer your old beams some serious headlight renewal, however, have you at any point considered how the modern headlight came to be? Here's a speedy overview of the history behind this basic yet fundamental segment of each vehicle available today. In the 1880s the primary headlamps are presented, energized by acetylene or oil. Acetylene lights were substantially more impervious

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1021-9986/2022/1/88-108 21/$/7.01

to wind and rain, yet they were a long way from dependable out in the components. Conveying a relentless stock of fuel to the lights was additionally troublesome. In 1898 the Electric Vehicle Company of Hartford, Connecticut, presents the main electric headlights on its Columbia model as a discretionary extra. Progressively electric headlights followed, however, we're restricted by the short life expectancy of the fibers inside the bulbs. 1917 Cadillac engineers a switch inside the vehicle that can control the progress among high and low beams. Before that point, you needed to escape the vehicle and "plunge" the lights physically. 1940 U.S. law requires all autos to come furnished with two 7-inch round fixed pillar headlamps, which obstructed further development in the innovation for quite a while. 1962 the principal halogen bulbs are utilized in Europe for vehicles, however, kept from entering U.S. production until 1979 because of the institutionalized guidelines. 1991 the BMW 7 arrangement presents the principal high-force release (HID) headlamps, which give considerably more grounded bars than halogen. 2004 Light-Producing Diode (LED) headlights initially hit the market with the Audi A8 W12, trailed by the 2007 Lexus LS 600h [1, 2].

Although the innovation keeps on advancing, in Pakistan still halogen bulbs are in the mainstream for four-wheelers while it is in the development stage for two-wheelers. Therefore, this project is unique in its type as it is the first time that a halogen-based lamp is being developed in Pakistan. Headlights have several parts related to them, yet they are expected to serve a similar capacity. Every front lamp is proposed to light up the street in the evening time or under low permeability conditions, like, extreme haze or downpour. It tends to be transformed to give high and low bars, varying. The high pillar provides long separation brightening though the low bar covers a shorter separation. Headlights are controlled by the automobile's battery. A car headlamp (additionally alluded to as a headlight) is a luminaire mounted on a vehicle and utilized to give enlightenment in front of it. Headlamps are intended to enlighten the street ahead and are required to be sufficiently splendid to permit the driver to see impediments around 100 meters before the vehicle around evening time or in lacking lighting conditions. Car headlamps are regularly arranged to switch a low bar and an upper beam (high beam). The high beam mode illuminates the front side in a wide range a good way off with ideally high luminance. The high beam mode is commonly utilized on the occasion the vehicle runs at rapid on a street where there are generally barely any front running vehicles. The low beam enlightens a nearby separation with a pre-indicated luminance altogether not to create glare to advance vehicles that incorporate approaching vehicles and driving vehicles and is utilized fundamentally when driving in a midtown zone. The headlamp can specifically illuminate forward a low bar just as a high beam with contrasts in light edges of light discharged from a light source and a light sum [3, 4].

The whole procedure of specifically illuminating the low beam and the high beam can be practiced by the driver's operation of turning a switch on and, or might be naturally turned dependent on the running condition of the vehicle. A lot of headlamps involve supposed projection optical frameworks which for the most part incorporate a curved reflector that centers the light produced by the light source over to a veiling implies which creates the light/dull cut-off and a focal point which results in the purported light appropriation in the street space. Numerous projector headlamp frameworks join a halogen or High-Intensity Discharge (HID) source with a reflector, a focal point, and a reasonable spread that shields working parts and improves appearance. Light Transmitting Diodes (LEDs) are progressively being acquainted with limited light design confusions and diminishing the quantity of assembling forms expected to create a headlamp. The LED can guarantee required brilliance with long life and less force and may discharge light with stable splendor under a basic control that provisions a steady presence there to be hence suggested as a light hotspot for a vehicular lighting installation [5, 6].

Different Types of Headlight

Halogen headlights are an improvement of radiant lights (fixed beam lights). Radiant lights are as yet utilized for great autos. All things considered, Halogens have genuinely taken over as the standard in many vehicles. Halogen lights produce a ton of warmth as power moves through the fiber and lights up the bulb. The heat production makes taking care of these bulbs very troublesome. Indeed, even modest quantities of dampness from your skin can decrease how they perform. Fig. 1 (a) halogen lamps make a more intense beam that can cover more distance. The expenses of assembling are generally low. This means the bulbs are modest contrasted with different alternatives.

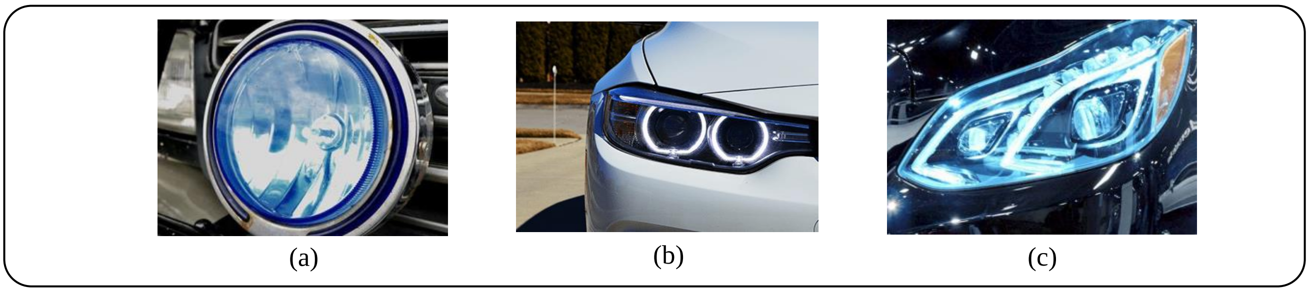


Fig. 1: Different Types of Headlight (a) Halogen headlamp (b) Xenon, HID headlamp (c) LED headlamp.

Color temperature is ordinarily around 3000K bringing about a yellow hue [5, 6].

Fig. 1 (b) shows xenon or High-Power Release (HID) lights don't utilize a metal fiber to make light. These lights make a high voltage circular segment between two terminals. You can think about this as a controlled electrical jolt occurring inside a little cylinder. The HID bulb is loaded up with xenon gas. As the xenon gas touches off it creates a splendid white/bluish light. This procedure makes far less warmth in contrast with halogen. Although, for the lights to come to full brilliance, they need time to heat up. When they are heated up, they are very bright. A few nations have even esteemed these lights too bright and aren't allowed to be utilized. Produce more bright light around 3,000 lumens and a lifetime of around 2,000 hours. They are excessively brilliant and can aggravate approaching drivers because of the mix of 5,000K to 8000K color temperature and lumen rating.

Fig. 1(c) shows LEDs or light discharging diodes are well known in newer autos. Retrofitting LED headlights is additionally simple and the update just takes 30 minutes. These lights work by changing overpower into light through diodes inside the headlight; the procedure is known as electroluminescence. This procedure is additionally more vitality proficient contrasted with halogen as meager to no heat is made. This implies the lights can last much more. LED headlights will be more costly. They additionally last more and the power of their light is stronger. This implies your downstreet permeability is improved and you're more secure on the road. The light is additionally tolerable for the drivers. More splendid than halogen and can run from 4,000 to 12,000 lumens.

Components of headlight

Headlamps are made up of many components. They consist of a reflector, screw, frame, housing, bulb, and lens. But the three main components in any headlamp. The major functional point of the reflector is to catch the best conceivable portion of the luminous flux transmitted by the bulb and to coordinate this towards the street. There are different distinctive reflector frameworks accessible to empower headlamp originators to meet this prerequisite as adequately as could reasonably be expected. A typical reflector comprises plastic molding with a metalized reflective coating. The metalized surface can achieve high reflectance although a lens ensures superior beam control. Halogen headlight utilizes a tungsten halogen fiber blended in with halogen gas to create a lot brighter light than traditional headlights. Including little amounts of halogen molecules, for example, iodine, and bromine can diminish the darkening of the light. Halogen bulbs can be worked at a higher temperature with a similar help life and hence offer more efficiency. The concave lens is used as a headlight on a car or bike because these concave lenses spread light on the road that can able to see so far on a road. It helps to be easily driven on road at night. It is used because concave lenses have the property of light dispersion meaning that if the light is passed through the concave lens will fall on a bigger area. It is utilized in vehicle headlights to send equal beams since it permits light to be centered around a solitary beam and gives more power to the light. This is the reason behind the use of concave lenses as headlights [5, 7].

Process flow of headlamp

The fundamental part of the headlight assemblage is the headlight bulb. The bulb is the source of light radiated from a unit. It creates light by passing electric flow by a fiber that sparkles because of electrical opposition. This light is revealed out of the unit by exceptionally planned reflectors that scatter the light over the review zone of the driver as shown in the process flow of the headlamp Fig. 2.

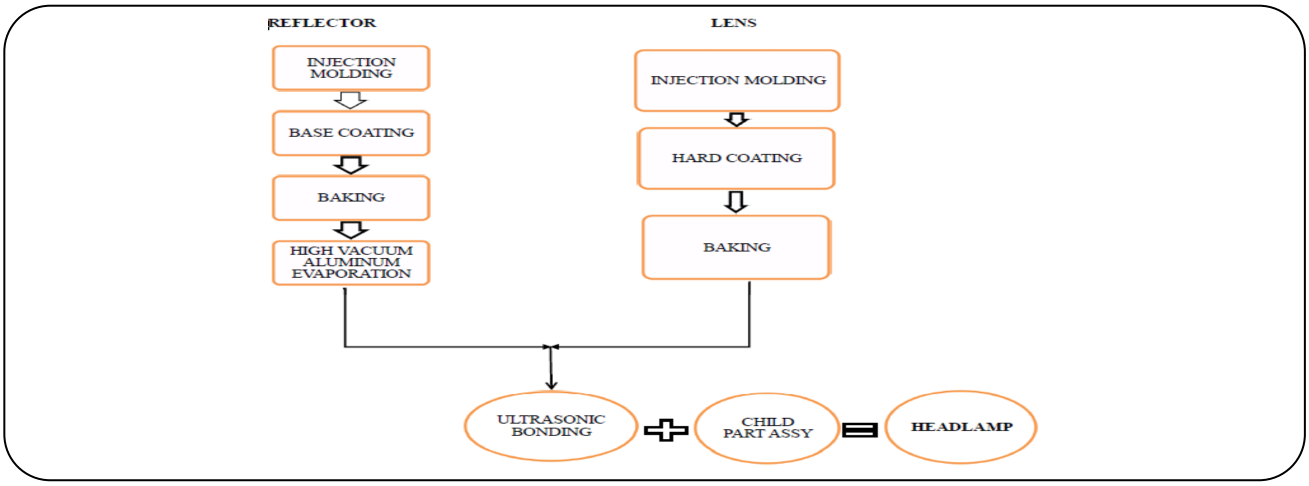


Fig. 2: Process Flow of headlamp.

EXPERIMENTAL SECTION

Required product properties and selection

A headlamp is used to illuminate the road which is done with the help of a bulb. When in service, the bulb generates heat which must resist by the material from which the headlamp is being made otherwise the material will start degrading. The front part of the headlamp that is, the lens, must be transparent so that it effectively and uniformly scattered light. Also, must have adequate impact resistance to withstand a slight collision and hold out against damage. Required properties for reflectors are high Heat Distortion Temperature (HDT) and toughness. Required properties for the lens are transparency, high Heat Distortion Temperature (HDT), and high impact strength. The materials that are generally used for the manufacturing of reflectors are Acrylonitrile Butadiene Styrene (ABS), polybutylene terephthalate (PBT), Bulk Molding Compound (BMC), polypropylene (PP), and polycarbonate (PC).

ABS is made out of three monomers acrylonitrile, butadiene, and styrene. It is an amorphous and obscure thermoplastic. The properties of ABS polymer rely on the proportions of acrylonitrile, butadiene, and styrene. Acrylonitrile brings compound obstruction, heat soundness, and elasticity to the polymer. Butadiene invigorates sway, low-temperature properties, and sturdiness. Styrene contains unbending nature and straightforwardness. ABS has a low softening point, which empowers its simple use in the infusion shaping procedure. The glass change temperature is 105 °C. The elasticity is high and gives great protection from physical effects and synthetic erosion, which permits the completed plastic to withstand overwhelming use and unfavorable ecological conditions. It tends to be fabricated to an excellent completion. A low dissolving point makes it not appropriate for high-temperature applications. It has poor dissolvable and weakness obstruction as well and doesn't stand up so well to UV presentation and enduring except if it is appropriately ensured. Its low conductivity implies that it can't generally be utilized in circumstances where this would demonstrate a block to the general plan. On consumption, the ABS material radiates a high smoke generation, which is the purpose behind air pollution [8, 9].

PBT is a semi-crystalline designing thermoplastic material. It has the same properties and structure as polyethylene Terephthalate (PET). It has a place with the polyester group of polymers. Polyester resins give brilliant electrical, thermal, and mechanical properties with great chemical resistance and dimensional stability. Polyesters additionally give low dampness assimilation and have good flow properties. It has magnificent machining attributes and is stain-resistant. It gives great creep resistance, dimensional steadiness, and low dampness absorption characteristics. It empowers the proficient utilization of material to lessen weight and cost. It gives phenomenal mechanical properties, for example, high quality, durability, and stiffness. The coefficient of Linear Thermal Expansion is 6-10 x 10-5/°C. Shrinkage is 0.5-2.2% [5, 10].

Bulk molding compound (BMC) is one of the basic composite materials with various building applications. It is a thermoset polymer resin with a mix of different inert fillers, catalysts, fiber reinforcements, stabilizers, and colors that structure a thick, molding compound. Contingent upon the end-use application, they are defined to accomplish dimensional control, fire and scratch opposition, electrical protection, erosion, and stain obstruction. It has amazing mechanical properties, low psychology, and color stability. Its smooth flow characteristics, dielectric properties, and fire opposition make this thermoset material appropriate to a wide assortment of uses requiring accuracy in detail and dimensions as well as high performance.

Polypropylene is a thermoplastic material that is formed by polymerizing propylene atoms that are monomer units, into long polymer chains of particles. There are various approaches to interface the monomers together, yet PP as a financially utilized material in most general structures is made with the impetus that produces crystallizable polymer chains. These offer ascent to an item that is semi-crystalline strong with great physical-mechanical and warm properties. When combined with different fillers such as talk, calcium, and glass, the mechanical properties of PP can be drastically changed. The thermal and mechanical properties of polypropylene are dependent on the tacticity, molecular weight, and other structural feature. It is an outstanding electrical insulation material, unaffected by moisture. PP is highly resistant to environmental stress cracking, chemicals like inorganic salts, dilute and concentrated minerals acid, and bases. It has an excellent surface appearance and it is a notch-sensitive material [5, 11].

Polycarbonate is a widely used thermoplastic resin due to its outstanding properties. It is a transparent and tough polymer that offers exceptionally high effect quality and a high modulus of versatility. It additionally has a high heat deflection temperature and absorbs very little moisture. It is self-stifling. Its effect quality and transparency likewise make it a perfect material for certain transparent applications. Polycarbonate shows amazing mechanical properties (Density: 1.20 – 1.23g/cm^3), having a strength of 140°C to - 20°C. Polycarbonate has amazing compatibility with different polymers. Consequently, it is generally utilized in mixes, for example, PC/PET, PC/ABS, and PC/PMMA. Polycarbonate is a decent material of decision in the industry because of its adaptable qualities, eco-friendly preparation, and recyclability. They have excellent chemical and physical properties which makes them reasonable over the glass, PMMA, PE, and so on. PC per allows light to transmit as well as glass. Polycarbonate offers great heat resistance and is thermally steady up to 135°C. Further heat resistance can be improved by including fire retardants without affecting material properties. Polycarbonate is a good material of choice in the industry because of its adaptable qualities, eco-accommodating preparation, and recyclability. They have incredible concoction and physical properties which makes them reasonable over the glass, PMMA, and PE. PC permits light to transmit comparable to glass. Polycarbonate offers great heat resistance and is thermally steady up to 135°C. Further heat resistance can be improved by including fire retardants without affecting material properties. Polycarbonate is chosen because of its high heat deflection temperature as halogen bulb delivers a great deal of heat because of which PMMA can't be utilized. Polycarbonate has been selected as it gives required properties including high HDT, good surface finish, and stability. BMC also has very high heat resistance but its processing is not available in Pakistan [8, 12].

Lens and Selected Material

The most visible part of the headlamp is the lens. The lens is presumably one of the most significant parts of the headlight since it has a few significant functions. Required properties for a focal point must have suitable optical properties. It must be solid (least versatile modulus and high fracture toughness), have great wear protection from opposing scratches (hardness), and should be unaffected by UV beams. The material is used for the manufacturing of lens polymethyl methacrylate (PMMA) and polycarbonate. The most important member of the acrylic group is Poly (methyl methacrylate), PMMA. It is a hard, clear, transparent plastic that is usually available in molding and extrusion pellets, and cast sheets. Methyl methacrylate is polymerized readily and free radical polymerization is used. Polycarbonate is a widely used thermoplastic resin due to its outstanding properties. It is a tough and transparent polymer that offers high effect quality and a high modulus of flexibility. It likewise has a high heat deflection temperature and retains no moisture. It is self-stifling. Its effect quality and transparency also make it a perfect material for various transparent structural applications [13, 14].

Processing Injection Molding

Fig. 3 shows injection molding is the way toward warming crude material resin in pellet form to its melting point,

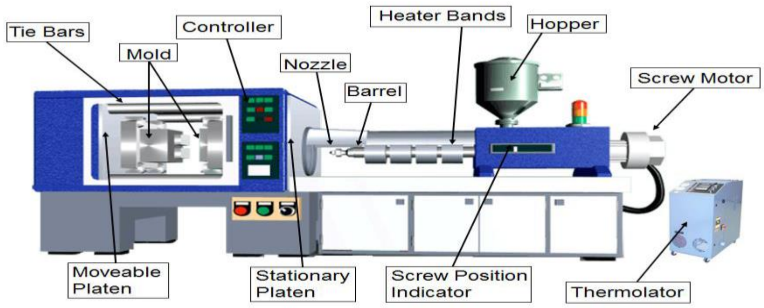


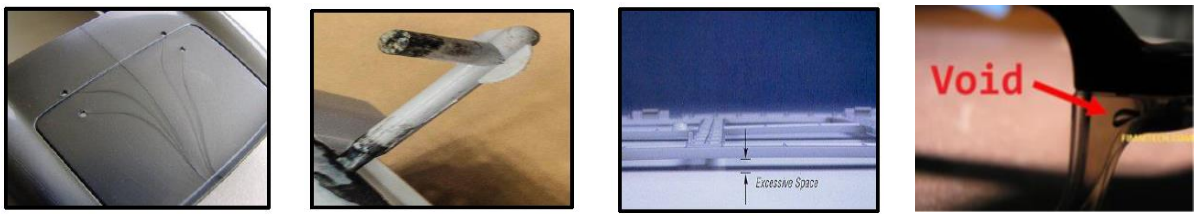
Fig. 3: Injection Molding Machine

constraining the thick material into a mold, and permitting it to cool into a solidified shape. Injection-molded parts are utilized for all intents and purposes for each product you experience, from electronics to housewares to automotive to food packaging. The technique is reasonable for the large-scale manufacturing of items with entangled shapes and takes an enormous part in the zone of plastic processing. Advantages originate from delivering parts through plastic injection molding. They incorporate a vast assortment of any shape you can consider can be made as a plastic part. Minimal effort per piece while there are forthright expenses for making the mold, exceptionally mechanized creation processes result in a very low cost for every part. High-yield parts can be formed rapidly. More economical than machining over the long run, plastic injection molding is significantly cheaper. Resource-conscious procedure the injection procedure utilizes just a lot of material varies for each part and any material left toward the completion of a procedure can be ground up and reused [15, 16].

The procedure cycle for injection molding is extremely short, around 2 seconds, and 2 minutes. Before the injection of the material into the mold, the two halves of the mold should initially be safely shut by the clamping unit. Every fifty percent of the mold is appended to the injection molding machine and one-half is permitted to slide. The hydraulically powered clamping unit pushes forward the mold halves together and applies suitable power to keep the mold securely shut while the material is infused. The required time to clamp and close the mold is needy on the machine, bigger machines will require extra time. The crude material as pellets is encouraged into the machine and proceeded to the mold by the infusion unit. During this procedure, the polymer material is softened by heat and pressure. This molten plastic is then infused into the mold rapidly and the aggregation of pressure packs grasps the material. The measure of polymer material that is infused is alluded to as the shot. The injection time is difficult to figure absolutely due to the intricate and changing flow of the molten plastic into the mold. In any case, the infusion time can be determined by the shot volume, power, and injection pressure.

The molten plastic inside the mold starts to cool when it reaches the inside mold surfaces. As the plastic cools, it will harden into the form of the looked-for part. In the duration of cooling, some part shrinkage may occur. The pressing of material in the injection stage permits extra material to stream into the mold and decreases the amount of visible shrinkage. The mold can't be opened until the necessary cooling time has elapsed. After adequate time has passed, the cooled part might be ejected from the mold by the discharge framework, which is joined to the back portion of the mold. Power must be applied to eject the part because during cooling the part shrinks and stick to the mold. To encourage the ejection of the part, a mold release agent can be showered onto the surfaces of the mold cavity before infusion of the material. After the injection molding cycle, some post-handling is commonly required. During cooling, the material in the channels of the mold will solidify and joined to the part. This overabundance of material, alongside any blaze that has happened, must be cut from the part, ordinarily by utilizing cutters or by any cutting material. The two primary segments of the mold are the mold cavity and the mold core. At the point when the mold is shut, the space between the frames and the part cavity will be loaded up with molten plastic to make the ideal part [15, 16].

Streamlines show up as a wavy pattern with different shading in comparison to the surrounding area and for the most part on smaller segments of the molded segment



(a) (b) (c) (d)

Fig. 4: (a) Flowlines (b) Burn Marks (c) Warping (d) Vacuum voids

as appeared in Fig. 4 (a). They may show up as a ring-formed group on an item's surface close to the entry points of the mold to move through. Stream marks won't regularly affect the respectability of the part however they can be undesirable whenever found in certain consumer products.

Fig. 4 (b) shows that burn stamps commonly look like dark or rust-shaded staining on the surface of a molded plastic part. Burn stamps typically may not influence part respectability, except if the plastic is burned to the degree of degradation.

Warping is the distortion that can happen in injection-molded items when various pieces of a segment shrink inconsistently as appeared in Fig. 4 (c). Similarly as wood can warp when it dries up randomly, plastic and different materials can warp through the cooling procedure when lopsided shrinkage puts undue weight on various zones of the molted part. This undue pressure brings about the bowing or turning of the completed part as it cools. It is clear in a part that is intended to lie flat however leaves a cavity when placed on a surface level.

Vacuum voids are caught air bubbles that show up in a completed molded component as appeared in Fig. 4 (d). In any case, bigger or progressively various voids can debilitate the formed part at times, as there's air beneath the outside of the part where there ought to be shaped material. Sink marks are a little break in an otherwise level and steady surface of a molded part. These can occur when the internal piece of a molded segment shrinks, pulling material from the outside inward.

Weld lines can show up on the outside of a molted part where the molten material has united in the wake of dividing into at least two bearings in a mold. The hair-like weld line is the consequence of feeble material holding, which brings down the quality of the part. Jetting refers to a sort of disfigurement in a molded segment that can happen when there's an underlying "fly" of liquid material infused into the mold cavity that begins to solidify before the cavity is filled. Jetting frequently shows up as a twisted line on the outside of the completed segment, commonly driving from the underlying door of injection. This visible flow example can bring about part weakness. Discoloration, or "shading streaking", happens when a molded part is an unexpected shading in comparison to the plan.

Frequently the discoloration is constrained to a restricted region or a couple of streaks of anomalous shading on a molded part. This imperfection normally influences the presence of the part without lessening its quality. A short shot emerges when the progression of molten material doesn't fill the depressions in a mold. The impact is that the formed part is fragmented in the wake of cooling. The short shot may show up as inadequate compartments in plastic racks of a presentation or missing prongs on a plastic fork. Short shots are normally named a significant imperfection that can hinder the capacity or presence of the molded part [5, 16].

Coating and baking

In the mid-1980s a new market for coatings emerged because of the superior properties they offered and process-related advantages including reduction in cycle time, elimination of pot life, and part storage defects. UV-curable coatings became more popular soon with the presentation of recyclable coatings. This was first done during the 1980s in the basecoat field with both shower and stream coat applications and has effectively been a standard procedure in the splash focal point covering the market since 1994. Due to continuous improvement in the coating application and the variety of advantages, they offer the in-process coating market is growing globally and locally. The coating is the utilization of thin layers for covering the outside of any article; mostly it is utilized to improve its basic properties and to make a defensive obstruction against the weakening of the surface because of its response to the condition. Lacquer provides gleaming and reflexive completions to surfaces. Lacquer is available for a variety of applications going from reflexive to ultra-matte. This permits you to choose a favored completion. Produce hard and tough completes, the plasticizers put into enamel give it an all the more hard-wearing completion. Lacquer, because of its dissipating solvents, will constantly dry on a surface a lot snappier. At the point when the enamel is prepared, it is broken down into an exceptionally combustible dissolvable that contains toluene or butyl acetic acid derivation and xylene. To limit the danger of combustion, lacquer is normally showered onto a surface inside a splash corner that clears any overspray [17, 18].

Metalizing

Metallization is defined as the application of a metal coating to another surface such as a non-metallic or metallic surface. There are a variety of coatings depending upon the applications and results that are required. For example, silver, aluminum, zinc, or gold. The metallization process protects the product from external forces that can damage the product, such as rusting, wear, and black spots. The appearance of the product is also increased by providing it a shiny, bright look and also increases the lifespan and functionality of the product. The metallization process is being used by many industries in their manufacturing processes. Automotive sectors, aerospace, and oil and gas companies widely use this technique.

Vacuum metalizing is the deposition of a film or covering in a vacuum (or low-pressure plasma) condition. In general, molecules or atoms are deposited one at a time known as vacuum metalizing, Low-Pressure Chemical Vapor Deposition (LPCVD) processes or Physical Vapor Deposition (PVD) also uses the same technique. Aluminum is the most commonly used metal for vacuum metallization. The reasons are due to its fine reflective properties, its high boiling point, and its cost to other metals. The evaporation happens by bolstering aluminum onto warmed sources or boats, which work at about 1500°C. The vacuum metallization chamber's air is emptied to a vacuum level suitable for the dissipation of the aluminum wire. Aluminum is first vaporized when a sufficient amount of heat is provided, and then forms a uniform layer on the product. The absence of pressure in the chamber decreases the boiling point of the metal. This permits the metal fume to condensate and structure a layer over your preferred highest point of a substrate. Electron bars, plasma, and warm warming are generally utilized simultaneously. At long last, a covered layer of metal is acquired running from the thickness of one particle up to millimeters [15, 18].

When a vacuum is created, the pressure of the gas is less than the pressure of the atmosphere. Plasma is created in presence of electrical conductivity in terms of electrons and ions are present. In general, atoms or molecules are deposited one at a time known as vacuum metalizing, LPCVD processes, or Physical Vapor Deposition (PVD) also uses the same technique. The vacuum in deposition handling expands the "mean free path" for collisions of particles and high-vitality particles and diminishes gaseous contamination to an adequate level. Plasma in a "good vacuum" gives a source of particles and electrons that might be quickened to high energies in an electric field. Ions and electrons which have high energy are used in PVD processing. They sputter and form a layer on the substrate. Ion bombardment impacts can also be found in LPCVD. The plasma enhances the reactivity of gases and aid in process of forming a metal layer. The variables influencing this covering thickness are inborn on-consistency in the dispersed pattern of fume from the source, abnormalities fit as a fiddle of the workpiece surface, and shadow impact which results when the supporting edge separates the workpiece and the fume source. Thickness can be constrained by controlling the procedure parameters, for example, fiber size and current, coating metal clasp size, level of vacuum, and vaporization time. These components of thickness are proposed for typical applications simple reflective coatings and decorative coatings, 0.05 to 0.13 μm, and erosion security coatings, 5 to 10 μm.

Creating a vacuum has two purposes to decrease the gas pressure enough so vaporized molecules have a long "mean-free path" and don't nucleate in the fume to shape soot. To diminish the level to the point that the necessary film can be deposited. The jigs hold the substrates to be deposited and give slowly move to give the desired coating. To achieve good uniform deposition or difficult and complex structures of products, it is necessary to keep it in motion. The fixture and process cycle durations define throughput. The deposition chamber is estimated to contain the jigs and give space to accessories, for example, screens, deposition rate screens, and radiators, if a good quality

Table 1: Pressure and vacuum ranges.

Pressure and vacuum	Range (Pa)	Range (mBar)
Atmospheric pressure	$1.013x10^5$	1013
Low vacuum	$1x105$ to $3x10^3$	1000 to 30
Medium vacuum	$3x103$ to $1x10^{-1}$	30 to $1x10^{-3}$
High Vacuum	$1x10-1$ to $1x10^{-7}$	$1x10-3$ to $1x10^{-9}$

product and desired deposition or coating are required then proper construction, design, use, and maintenance must be done. Table 1 shows the pressure and vacuum ranges [19, 20].

The main parts which are to be assembled are a polycarbonate reflector, halogen bulb, and polycarbonate lens. However, there are different technologies to bond reflectors and lenses.

Bonding techniques

As of now accessible advances in electro polymers ultrasonic welding, hot soften cement, and RTV silicon holding. Ultrasonic welding is the joining of the thermoplastics part using heat produced from high-recurrence mechanical movement. It is finished by changing over high-frequency electrical vitality into high-frequency mechanical movement. The applied power makes heat on the plastic segments' mating surfaces so the plastic material will melt and form a nuclear bond between the parts. Hot-melt adhesives are bonding materials (thermoplastic-based) applied as melts that accomplish a solid-state and resultant strength on cooling. Hot melt adhesives have no water and no solvents. They can bond two non-permeable materials. A polymer gives the adhesive strength and a level of adaptability. Resins invigorate the prompt cohesive strength of the adhesives. The most significant attributes of hot-liquefy adhesives are service temperature. Service temperatures of hot melts are low as a result of their low liquefying temperatures, which is a drawback. A hot melt is applied to a material in a liquid state. The time in the middle of applying the adhesive and acquiring the subsequent material contact is called open time. When the other material is brought into contact, the adhesive chills off and hardens exceptionally quickly.

Room Temperature Vulcanization Silicone is a sort of silicone elastic that is by and large provided as a one-section framework with a wide range of viscosity. It comprises a blend of natural and inorganic compounds that make it one of the steadiest natural adhesive items. These adhesives and sealants are impervious to high temperatures. RTV Silicone cement and sealants use water and a restoring operator, or component to shape an adhesive bond or seal. At the point when these materials consolidate during crosslink, a substance side-effect is discharged. Contingent upon what materials you are utilizing, this side-effect can be basic, acidic, or neutral. The curing agent that you use will define the final properties of your adhesive. RTV silicones will in general fix within 72 hours, even though the adhesive can keep on reinforcing for as long as about fourteen days after setting. The bonding technique used in this research is ultra-sonic welding. The result showed that only ultra-sonic bonding passed the shower test whereas both hot melt and silicon bonding fails because of the presence of water more than the required amount [19, 21].

RESULTS AND DISCUSSION

The processing of the manufacturing of headlamps involves three major steps. Injection molding, high vacuum aluminum evaporation, and assembly.

Injection Molding

The first step in the manufacturing of a headlamp is making of reflector and lens which are made by using injection molding. So, to make these two parts, a 280-ton injection molding machine was used. Our main task is to manufacture headlamps so by this, we find a way to develop headlamps by the injection molding machine. Its main parts are a reflector, lens, and bulb. So, first, we have to check the machines in which machine we could work for making this task possible so for lens and reflector polycarbonate material is used. The machine specifications are shown in Table 2.

Since the material utilized for assembling of reflector and lens is polycarbonate. Therefore, to keep up the temperature of the mold, the thermal controller was used as shown in Fig. 5. Temperature control units are utilized to preheat the mold and afterward to keep the mold at the temperature set point by circling coolant (water or oil) through the mold. The coolant retains heat from the mold and keeps the form at a legitimate temperature to harden the plastic. It is mainly used while working with polycarbonate material because mold always heats up.

Table 2: Machine specifications.

Parameters	Value	Unit
Mould clamp force	280	ton
Screw L/D ratio	220	--
Number of heating zones	4	--
Screw diameter	50	mm
Space between tie bars	570*570	mm
Mould platen	860*860	mm
Mould thickness	200-650	mm
Theoretical shot volume	491	cm^3

Table 3: Initial parameters for reflector

Parameters	Value	Unit
Clamping force	280	(Kg/cm^2)
Injection speed	90	(mm/sec)
Screw displacement	10	(mm)
Back pressure	5	(Kg/cm^2)
Holding pressure	130	(Kg/cm^2)
Injection pressure	160	Ton
Cycle time	50-60	sec
Cooling time	25	sec
Mold temperature	70-80	ºC
The temperature of barrels (Zones)	(Metering), (Compression), (Feed) (291), (285, 275), (261)	ºC

Fig. 5: Thermo controller.

The mold used for processing of reflector consists of the mold cavity is a single cavity, and the runner system is a cold runner, the gate is an edge gate, the ejector is a pinned ejector, mold weight is 430 kg and mold dimensions are 450x470x390 mm. Table 3 is the initial parameters set for the reflector and afterward, trials were started. Parameters were set and trials for reflector were started. Initially, screw displacement was minimum resulting in short molding. It is a safety precaution to prevent damaging the mold. Up to trial 7, short molding was observed at a screw displacement of 40mm. Fig. 6 shows after trial 9, flashes were starting to appear because of an increase in screw displacement. Therefore, screw displacement was reduced and the complete part was taken out at a screw displacement of 44mm.

Table 4 initial values until our final product was made with their respective product weight and the screw displacement.

Fig. 7 clearly shows that as the screw displacement increases our material will go forward and fills the cavity so the weight of the product increases simultaneously.

Fig. 8 (a) shows the defects which were observed during the processing of reflectors. Soaking is the uneven

Table 4: Observations of the reflector.

Number of Trials	Screw Displacement (mm)	Product Weight (gm)	Observations
1	10	50	Short cavity
2	15	60	
3	20	71	
4	25	79	
5	30	86	
6	35	92	
7	40	98	
8	44	101.5	
9	48	106	Flashes
10	44	102	Complete part

Short Molding Short Molding Flashes Complete Part

Fig. 6: Trials during processing.

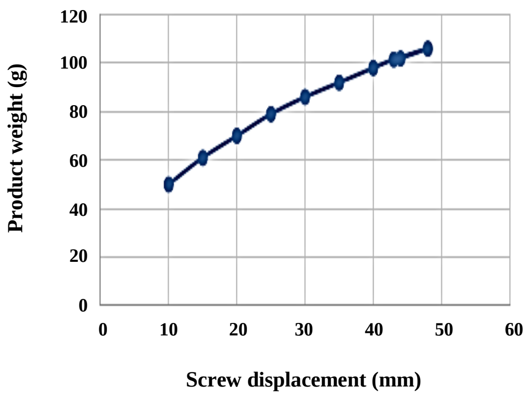


Fig. 7: Screw displacement versus product weight

the surface of the product which is caused during processing. It occurs due to the high temperature of the barrel, low injection pressure, low holding pressure, and if backpressure is not provided. The defect was removed by reducing the temperature of the metering and compression zone by 5ºC and by increasing the injection pressure by 5 kg/cm^3. Table 5 shows the observations of the soaking defect.

Fig. 8 (b) shows a gas mark, as the name indicates it's a defect of setting marks or lines on the product. It is caused due to improper drying of material, over-temperature of the barrel, and if backpressure is not provided. The observations of gas mark defect temperature before (291), (285,275), (261) ºC and after (285), (280,275), (261) ºC. The defect was removed by reducing the temperature of the compression zone by 5ºC. The mold used for processing of lens of consists of the mold cavity is a single cavity, the runner system is a cold runner, the gate is the edge gate and the ejector is a pinned ejector. Next move towards the lens, the parameters for processing of lens. Table 6 is the initial parameters set and afterward, trials were started.

Parameters were set and lens trials were started. Initially, screw displacement was minimum resulting in short molding. It is a safety precaution to prevent

Table 5: Observations of soaking defect.

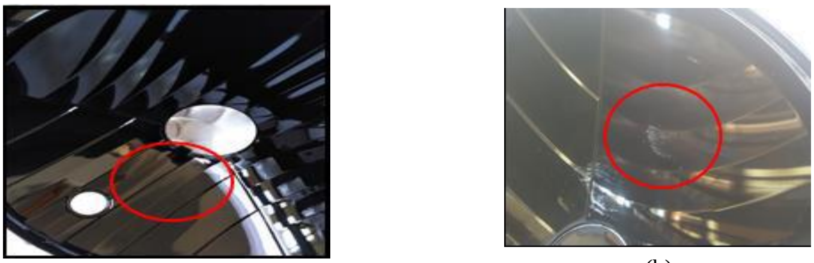
Parameters	Before	After
Temperature (ºC)	(291),(285,275),(261)	(285),(280,275),(261)
Injection pressure(kg/cm^2)	160	165

Table 6: Initial parameters for lens.

Parameters	Value	Unit
Clamping force	280	Ton
Injection speed	60	(mm/sec)
Screw displacement	10	(mm)
Back pressure	5	(Kg/cm^2)
Holding pressure	85	(Kg/cm^2)
Injection pressure	155	(Kg/cm^2)
Cycle time	50-55	sec
Cooling time	20	sec
Mold temperature	70-80	ºC
The temperature of the barrel (zones)	(Metering), (Compression), (feed) (290), (285-275), (260)	ºC

Table 7: Observations of lens.

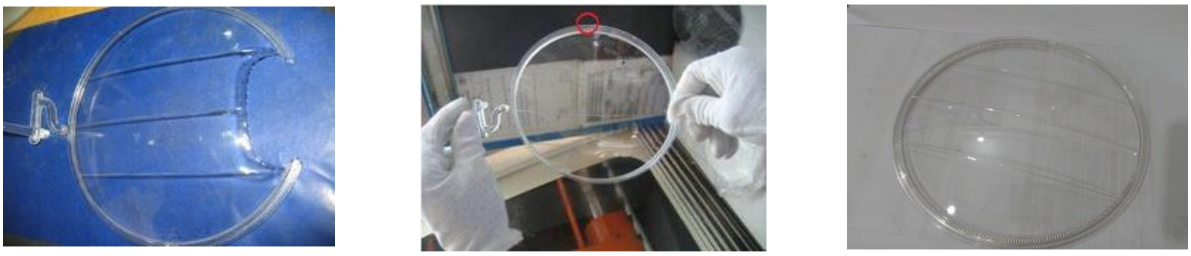
Number of Trials	Screw Displacement (mm)	Product Weight (gm)	Observations
1	10	45	Short cavity
2	15	52	
3	20	60	
4	25	66	
5	30	72	
6	35	80	
7	40	86	
8	45	94	Flashes
9	42	90	Complete part



(a) (b)

Fig. 8: (a) Soaking (b) Gas mark

damaging the mold. Fig. 9 shows up to trial 7, short molding was observed at a screw displacement of 40mm. After trial 8, flashes were starting to appear because of an increase in screw displacement. Therefore, screw displacement was reduced and complete parts were taken out at a screw displacement of 42mm. Table 7 initial values until our final product were made with their respective product weight and the screw displacement.



Short Molding Flashes Complete Part

Fig. 9: Lens trials during processing.

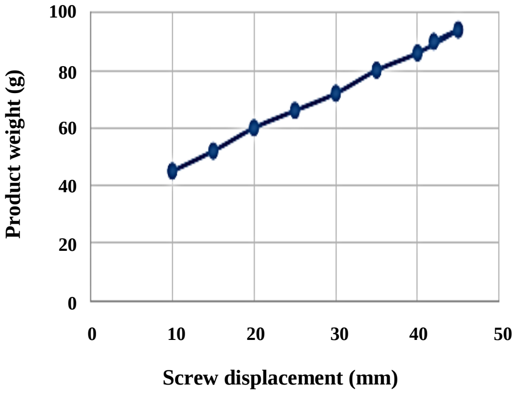


Fig. 10: Screw displacement versus product weight

Fig. 10 clearly shows that as the screw displacement increases our material will go forward and fills the cavity so the weight of the product increases simultaneously.

Fig. 11(a) shows the defects that were observed during the processing of reflectors. Since the lens must be transparent. Therefore, a single black spot is also considered a defect. It is caused by improper cleaning of the barrel and overheating of the material. Observations of black spot defect are temperature before (290), (285, 275) (260) ^oC and after (290), (280 275), (260) ^oC. The defect was removed by reducing the temperature of the compression region by 5 ^oC.

As the name suggests it is caused by high pressure, due to overheating, and injection speed, and also occurs due to airlock in mold resulting in impressions in terms of the lines on the part as shown in Fig. 11 (b). Observations for pressure line defect injection pressure before 155 kg/cm^2 and after 150 kg/cm^2. The defect was removed by reducing the injection pressure by 5 kg/cm^2.

Coating and Baking

After injection molding, the next step is coating spraying on the reflector and lens in a spray booth followed by removing excess naphtha which will help in the next process of vacuum metalizing. Lacquer booth used for coating on reflector and lens both is side downdraft type as shown in Fig. 12. The lacquer booth is perfectly sealed and a vacuum is created inside. There are two fans of vacuums and two fans of fresh air above the booth. These conditions are created to make a dust-free environment inside the lacquer booth. There is running water inside the booth which is changed after 15 days. The coating on reflectors is normally basecoat. Basecoats are characterized as a covering applied directly to the bezel or reflector substrate. The reason for this coverage is to give a smooth, reflexive surface with the goal that when metal, most regularly aluminum, is stored using a vacuum procedure, the completed part shows a gleaming appearance.

In the base coat, we use two components resin and thinner is used to reduce the viscosity and improve flow. All coatings are done in a sealed chamber to prevent the parts from dust particles. Charges are removed from the part before coating through antistatic guns. For the application of the coating, there are three different ways manual, automatic flow, and robotic. We are doing it manually. Ratio 1:3 resin and thinner. The gun-type used for coating the reflector is a High Volume Low {ressure (HVLP) pressure feed gun as shown in Fig. 13 [13, 22].

Setup for basecoat cleaning of the gun before preparation of the mixture, oven temperature 70-80^{o}C, filter the hard coat mixture, rinse the gun pot and gun with coating thinner and fill the gun with the filtered mixture. Set the air and basecoat flow by spraying on metallic gun plates, checking off the reflector concerning inspection standards, and if any non-conformity is found. Make changes in the setting of the gun and verify spray quality on glass/metal before starting the production. Preparation of mixture wash three beakers with solvent and resin. Take out two components in different beakers


(a)

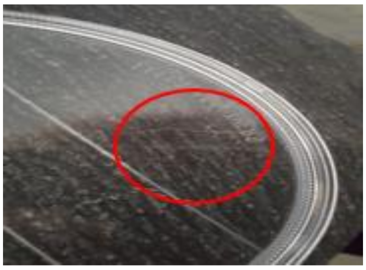

(b)

Fig. 11: (a) Black spot (b) Pressure line

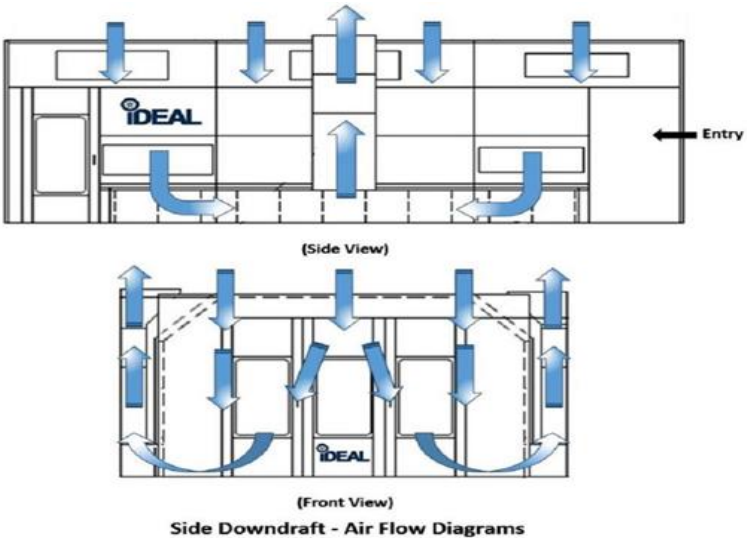


Fig. 12: Lacquer Booth.

Fig. 13: Pressure feed spray gun.

from their container manual pump. Put a large beaker on the weighing scale and set all beakers to zero and add a ratio of 1:3 resin and thinner, the mass of a sample of base coat is shown in Table 8.

After the coating of lacquer, the part is put into the oven to remove the excess naphtha. Fresh air is provided in the oven with the goal that the naphtha which is dissipating ought to be taken off the stove or else it will harm the part. The temperature of the oven was set to 80ºC and the baking time was set to 35 to 40 minutes. The reflector was then sent to a vacuum metalizing chamber so that its surface is coated with shiny aluminum metal which will help in directing the light towards the road. The coating on the lens is a hard coat. Hard coating is applied to the lens to improve its scratch resistance and u\v degradation property. In hard coats, we use three components resin, hardener, and thinner. Thinner is used to reduce viscosity and improve flow. All coatings are done in a sealed chamber to prevent the parts from dust particles. Charges are removed from the part before coating through antistatic guns. Ratios of thinner, hardener, and resin are 6:0.3:5 respectively. The gun type used for coating on the lens is a High volume low pressure (HVLP) gravity type gun [17, 23].

Table 8: Mass of a sample of base coat.

Before applying a base coat (g)	After applying a base coat (g)	Mass of base coat(g) =After-Before
92.43	92.598	0.168
90.21	90.36	0.150
91.37	91.531	0.161

Table 9: Mass of the sample of the hard coat.

Before applying a hard coat (g)	After applying a hard coat (g)	Mass of hard coat(g) =After-Before
78.2	78.376	0.176
78.34	78.55	0.21
82.18	82.36	0.18

Setup of hard coating cleaning of the gun before preparation of the mixture, oven temperature 80-90ºC, filter the hard coat mixture, rinse the gun pot and gun with coating thinner and fill the gun with the filtered mixture. Set the air and hard coat flow by spraying on metallic gun plates, and checking off the lens concerning inspection standards. If any non-conformity is found. Make changes in the setting of the gun and verify spray quality on glass/metal before starting the production. Preparation of mixture wash four beakers with solvent and resin, take out all three components in different beakers from their container through the manual pump. Put a large beaker on the weighing scale and set all beakers to zero, add a ratio 6:0.3:5 (thinner: hardener: resin) by weight, and Table 9 shows the mass of a sample of the hard coat.

After the coating of lacquer, the part is put into the oven to remove the excess naphtha. Fresh air is also supplied in the oven so that the naphtha which is evaporating should be taken off from the oven or else it will damage the part. The temperature of the oven was set to 90 ºC and the baking time was set to 35 to 40 minutes. The lens is then directly sent to the assembly department where is assembled along with the metalized reflector and other components.

Vacuum Metallizing

There are several processes from which metalizing can be done but the most effective method is high vacuum aluminum evaporation. After the reflector had gone through injection molding, base coating, and oven processes, the next step is the coating of the reflector surface with aluminum to give it a bright shiny look and to aid in directing the light towards the road. Vacuum metalizing is the deposition of a film or coating in a vacuum (or low-pressure plasma) environment. In general, atoms or molecules are deposited one at a time known as vacuum metalizing, Low-Pressure Chemical Vapor Deposition (LPCVD) processes or Physical Vapor Deposition (PVD) also uses the same technique. The vacuum metallization chamber's atmosphere is evacuated to a vacuum level suitable for the evaporation of the aluminum wire. Aluminum is first vaporized when a sufficient amount of heat is provided, and then forms a uniform layer on the product. The vacuum is created in the metalizing machine by using three pumps, which suck air from the chamber and the vacuum is built inside the machine. There are three pumps used to create a vacuum; rotary pump, micro booster pump, and diffusion pump [24, 25].

A rotary pump is a positive displacement pump. Rotary vane siphons (generally called rotating siphons) take a volume of gas at low pressure; compress it with the goal that the pressure turns out to be marginally higher than climatic, coming the gas to the environment. The rotary pump provides an initial vacuum. Valve 1 is open, valves 2, 3, 4 are closed. A gas booster pump is used to increase the pressure of the gas above atmospheric pressure. It has a single-stage compression. It is quite the same with a gas compressor but the machine mechanism is simple because of single-stage compression. But there are also two-stage compression boosters available. They are normally used to transfer pressure gas, increase the pressure of the gas, and scavenge. It causes more vacuum to the chamber than the rotary pump. Valve 1 is open, valves 2, 3, 4 are closed. A diffusion pump does most of the work in creating

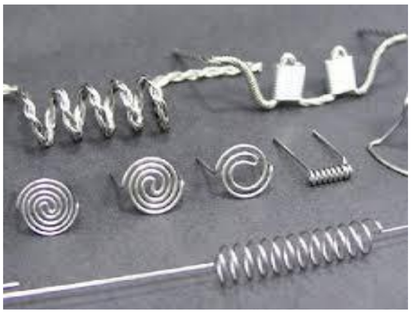


Fig. 14: Coils.

Fig. 15: Dustproof test.

a vacuum and works on the principle of diffusion of a gas. First, enough heat is provided in the diffusion pump so that the oil reached its boiling temperature. Vertically hollow cone compressed the vapors of this oil which are moving up. On the other hand, oil vapor emissions from the top of a hollow cone. The water circulating along the wall collides with the vapors of oil that are moving at very high speed and then move down. The air which is trapped at the end of the diffusion pump is released. This makes differential pressure in the diffusion siphon. The pressure at the top is least (high Vacuum) and at the base is most extreme (low Vacuum) from the base of the Pressure siphon the air is sucked by a rotating siphon. Here the pressure is maintained at a $2.6x10^{-4}$ m bar. Valve 1 is closed and V2, V3 are opened.

There are two stages involved in the metalizing machine as shown in Fig. 14. Preheating of filament up to 2.5 volts to stop the sudden melting of aluminum. Then the voltage is provided up to 5.5 volts to 5.9 volts to start evaporating the aluminum. After the coating of aluminum, valve 4 is opened, and valves 2, 3 are closed. And it sucks air from the environment to the chamber to gain pressure.

Assembly

After the reflector was coated with a metalized layer of aluminum from vacuum metalizing. The next step is to assemble all the parts. Bonding between lens and reflector, fitment of bulb, and frame were carried out step by step in the assembly line. To remove any dust or fiber particles from the reflector and lens air is applied using an air gun. To join the reflector and lens ultrasonic welding was used. The essential rule of ultrasonic welding is the two sections that must be amassed are put together, lens over the reflector, in a strong home, called an installation. A titanium or aluminum part called a horn is conveyed into contact with the upper plastic part. An adjustable pressure is applied to the parts, clamping them together against the apparatus. The horn is vibrated vertically 20,000 (20 kHz) or 40,000 (40 kHz) times each second, at separations estimated in thousandths of an inch (microns), for a predetermined measure of time called weld time. The clamping power is applied for a predetermined timeframe to permit the parts to intertwine as the liquified plastic cools and hardens. This is known as hold time. As the liquefied zone has cemented, the clamping power is expelled and the horn is withdrawn. The two plastic parts are presently consolidated as though molded and are expelled from the machine as a single part. In this step halogen bulb along with a clip is fitted to the headlamp and the frame is attached to it. As the headlight is completed a final inspection is done before packing.

Dustproof and Luminous Intensity Test

This test is done to check the weather ability of automobile parts. This test was performed according to JIS standard JIS-D5500 is shown in Fig. 15. Dust and sand-proof tests simulate the environment of the dust-filled atmosphere to test product sealing and dustproof test properties. The acceptable criteria of the lamp after the test is performed depend upon the luminous intensity measurement. A reduction in the maximum light intensity to be by 10% or less is allowed. The light was mounted in a tightly closed container in which each length, width, and height apart 150mm or more from the wall. 5 kg of Portland cement was placed in the container. Air was blown for 2 seconds at intervals of 15 minutes so that the dust diffuses uniformly throughout the container. Simultaneously, the lamp was operated at 30 min cycle (15 min lighting on and 15 min lighting off) and the test was continued for 5 hours in total. After the test, the dust on the surface

Table 10: Dust and intensity tests result.

Lighting point	Luminous intensity (LUX) (Before)	Luminous intensity (LUX) (After)	Percentage decrease in intensity	Remarks
1	151	146	3.3%	Ok
2	430	410	4.65%	Ok
3	200	185	7.5%	Ok
4	104	95	8.65%	Ok
5	167	165	1.2%	Ok
6	88	80	9.0%	Ok

Fig. 16: Luminous intensity test.

is wiped off and the maximum luminous intensity of the lamp is measured [16, 26].

For lighting reasons, the illuminators assume a significant job. A good lighting structure is accomplished by the decision of proper illuminating presences as shown in Fig. 16. The idea of the light discharged by the light and light control relies upon the kind of light source, the light reflection, and the transmitting framework. The fundamental standard of luminous appropriation estimations: mounting a photometric locator in the area of specific good ways from the center of estimated light. The light sign will be handled by the locator as per a relationship after entering the photograph identifier, at that point, the estimation of iridescent intensity is obtained. The light was mounted on a jig and placed at a minimum of 10 meters from the screen of the light receiver. There were six lighting points of measurement on the screen. The test was started by measuring the middle one, which had the highest luminous intensity because it was directed directly towards the center of the lamp. The remaining lighting points were measured one by one and then it was compared with the previous results of the luminous intensity test.

At different lighting points, different luminous intensity distribution was observed in Table 10. The dustproof test is used to check its weather ability against the dusty environment. The results show that before and after the dustproof test, the luminous intensity does not decrease than the allowed percentage of 10%. Hence the lamp can be used because it is up to the given required standards.

Temperature Resistance Test

In a heat resistance test, specific lamp bulbs are used for lightening, they are installed within a thermostat in a normal service condition. The test is carried out by applying a specific voltage over a while of one hour. This test is performed according to JIS D 5500. Construction of the chamber for temperature resistance test was also part of this project. It was constructed according to the standards of JIS-D5500. The equipment and necessary items required for the completion of the chamber are wood for the basic structure of the chamber, acrylic sheets, a holding jig, a fan, thermocouples, a heater (220 volts), an anemometer, and thermo controller. The basic structure of the chamber was laid down by keeping in mind all the test requirements and equipment that were to be placed inside the chamber. For this, the wood was cut down into 42-inch, 30 inches, and 30 inches for length, height, and width respectively shown in Fig. 17. All these sections were assembled with the help of screws and nails along with two acrylic sheets of 42-inch length and 30-inch height. After the basic structure was constructed, a holding jig was made and then placed 8 inches from the side and in the middle of the width. The fan was placed 30 inches from the holding jig as it had to maintain the air, striking the headlamp to be 0.5 m/s. and the air was checked by using a digital anemometer. The heater was placed between the jig and fan at a distance of 18 inches from the jig and 12 inches from the fan. Three thermocouples were installed, one near

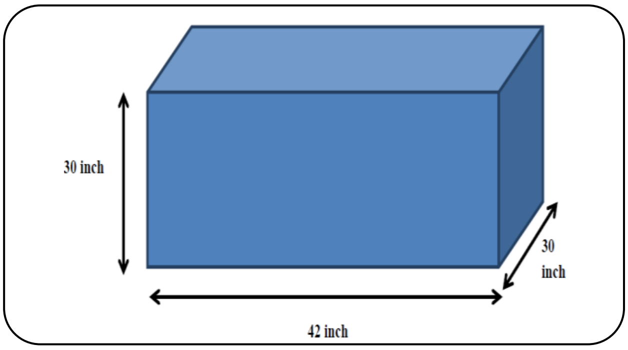


Fig. 17: Basic structure of the chamber

Fig. 18: Temperature resistance test.

Fig. 19: Shower test.

the lamp and two near the heater and fan to check the temperature. A Thermo controller was also installed to maintain the temperature of the chamber which is, 40ºC with a tolerance of ±2ºC [5, 7].

The temperature of the chamber should be maintained at 40ºC and the test should be carried out for one hour. The applied voltage is 14 volts. Wind speed should be maintained at 0.5 m/s. At least three samples should be tested. The light was fixed on the jig, connecting all the thermocouples, maintain the temperature to 40ºC, and adjust the fan speed to 0.5 m/s as shown in Fig. 18. In this test, three samples were tested. The tests were carried out for one hour each. And after one hour, every sample was observed. After the test, no deformation, crack, melting loss or breakage of the part was observed. Also, the temperature of the chamber didn't increase to the specified temperature of 40ºC. It showed that the chamber was manufactured correctly. Hence, no defect was observed and the samples were up to the given required standards.

Shower Test

This test is performed by the Japanese International Standard (JIS D 0203). The scope of this standard is to specify the methods of moisture resistance tests and waterproof tests for automobile parts shown in Fig. 19. The lighting device is placed in a service state and allowed to stand for one hour. The headlight is placed 400 mm from the shower. The sample on the mounting device should be rotated at 17 revs/min. The flow rate of spray water is to be maintained at 24.5L/min. the allowable limit of water inside the headlamp for the acceptable part is 2ml. The headlamp was mounted on a platform and kept at a distance of 400mm from the shower source. Close the chamber and turn on the machine. The water starts to shower at a constant flow rate of 24.5L/min. The test continues for 1 hour. After 1 hour the machine is turned off and the headlamp is removed for analysis.

In this test, three samples were tested. The three samples were bonded with different assembling techniques and then tested to find out which technique was best suited to the required specifications. Table 10 of different types of bonding and their respective results. The results showed that hot melt adhesive bonding and silicon bonding were rejected because it exceeds the maximum water limit of 2ml. Whereas ultra-sonic welding was accepted since no water content was observed. Hence shower test showed that ultra-sonic welding is the only technique that fulfills the required specifications.

Shock and Vibration Resistance Test

These tests were performed by the Japanese International Standard (JIS D 1601). The test is designed to determine the durability of different parts of the headlamp against higher frequency and amplitude. The headlight is mounted on a jig and vibrates at a rate of 750 times/minute for one hour. The shock of 265N to 314N was applied by spring and is caused by a drop of 3.2m caused by cam action. The headlight is mounted on a jig

Table 10: Different types of bonding with results.

Image	Type of bonding	Result	Remarks
	Hot melt adhesive	Water content > 2ml. Exact content = 5ml	Rejected due to high water content. Leakage
	Silicon bonding	Water content > 2ml. Exact quantity=8ml	Rejected due to high water content.
	Ultra-sonic welding	No water content observed	Accepted since it fulfills the requirement.

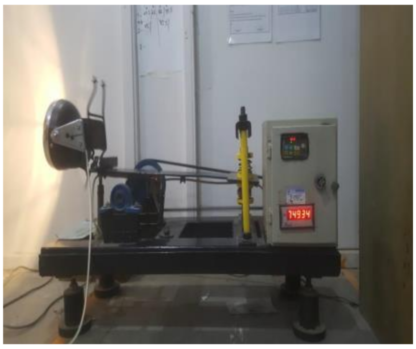


Fig. 20: Vibration and shock test.

and vibrates at a rate of 750 times/minute for one hour. The light was kept on for 30 minutes and kept off for 30 minutes shown in Fig. 20. The part was placed on a fixture. The rpm was set according to the given standard which is 750 times/minute. The test was performed for one hour (half hour on/off). The part was removed from the fixture and checked if any cracks or deformation were there.

Shock and vibration tests were both performed on the same equipment. The only difference between the two tests was the spring force and cam distance. The shock result showed that no deformation, fall of the lens, or loosening of the part took place when it was provided with the shock of 265N to 314N. While for the vibration test, continuous vibration was provided for one hour and after one hour, no fall down of lens, wires loosening, or bulb rotation was observed. Hence both tests showed that proper fitment, and assembling was done. And it was up to the required standards of JIS D5500.

CONCLUSIONS

The headlamp is one of the major parts of an automobile. The headlamp is for granted that is until something turns out badly. Headlights have many parts connected with them, yet they all are proposed to serve the primary function. There are three main parts of a headlight Reflector, Lens, and halogen bulb. Manufacturing of headlamps goes through these major processes injection

injection molding, coating, metalizing, and assembly. Our main task was to use a halogen bulb that generates heat. The temperature inside was 110°C. By the comparative study of the material, it was found that Polycarbonate was best suitable for both reflector and lens because it can withstand inside temperature. After completing all the manufacturing process samples undergoes different test results are shown in the Test analysis chapter. The samples are tested with different bonding techniques and only the ultrasonic bonding technique meets the requirements. It was concluded that after performing the test, the results showed that the product was up to the required standards and can be put for mass production. Developing LED Headlamps in Pakistan for a two-wheeler vehicle. Since Halogen-based headlamp is already in development so the next technology would be considered LED headlamps. LED headlamps generate less heat and produce brighter light. LED headlamps are difficult to design and process therefore different processing techniques and materials can be suggested for development.

Acknowledgment

The authors would like to acknowledge the Department of Polymer and Petrochemical Engineering, NED University of Engineering & Technology, Karachi, Pakistan for supporting this research work.

Received : Jul. 14, 2020 ; Accepted : Oct. 19, 2020

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