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# Advancement Of Fabric Lighting Technology Study Analysis For Vehicle Interiors

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***Abstract:*** Mood lighting is one of the key features in vehicle which gives premium feel to the Customer. It is also one of the main USP Features for the OEM's. Mood lighting works with a Light strip/Guide with LED. This system faces disadvantage mainly for vehicle packaging issue with the Interior elements. Existing mood light systems does not offer display of fluidic and geometric patterns. Hence, providing limited emotional connectivity with the occupants.

Smart Fabrics are developed to provide the customer of choosing geometric & fluidic patterns which further will give emotional connectivity with the Vehicle interior Lightings. Smart Fabric (Fabric lighting advancement) uses Polymer optical fiber (POF) fabric where bunch of polymer optical fiber are connected with concealed packaging of RGB LED Light source. Based on lighting requirement single or multiple units can be utilized. This unique experience can be provided in all vehicle interior parts (Door Trims, Headliner, Console, Seats). This concept results in improving aesthetics of Vehicle Interior & also no vehicle packaging issue to accommodate. Same fabric can be utilized for different door trim shapes to carry over the same in different boundary conditions.

Lightings can be controlled by telematics (mobile app) & infotainment system (like mood lighting). This provides exceptional user experience for the customers.

Major advantage of smart fabrics is that we do not need any major tooling changes to implement in existing interior parts.

***Index Terms*** **-** Smart fabrics, Polymer optical fiber (POF), Mood lighting, Light guide, RGB module, Vehicle interior lightings, Geometric pattern on fabrics.

## I. INTRODUCTION

Mood lighting is evolved in different applications of automotive, smart homes, aerospace & other domains. In traditional mood lighting most of the vehicle uses indirect lighting method with a LED strip. This further is not interactive or does not have emotional connect with customers.

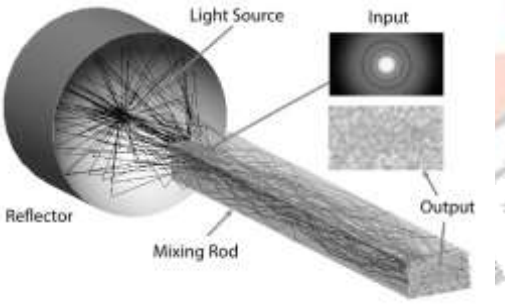
To improvise user experience smart fabrics is introduced. It is derived for unique experience by customers over the traditional mood lighting. Fabrics geometrical patterns can be felt by customer during physical engagement with the vehicle trims part as it has geometrical patterns in 'Aesthetic' surface of fabrics. Also, smart fabrics can be controlled with different light colors and the patterns are also customizable based on customer requirements.

This paper further contains the fabrics market, detailed study of polymer optical fiber (POF) application & integration, Smart fabric application & working. Including a smart fabric in vehicle will be a unique experience to customers.

## II. TRADITIONAL MOOD LIGHTING

Figure 1: Mood lighting in door trim and dashboard

Figure 2: Existing door trim light guide




Automotive mood lighting is growing in demand and is a major part of Interior illumination system. Generally, OEM's use the single lit & edge lit direct or indirect lighting method for mood lighting purpose.

Existing mood lighting solutions are limited in terms of lighting effects and are subjected to vehicle packaging. Customers prefer dynamic effects & interactable fabric in vehicle condition which can be achieved by smart fabric concept.

## III. FABRICS MARKET

Table 1: Fabric strategical market

| Phase 1: Innovation | Phase 2: Development | Phase 3: Maturity |
|---|---|---|
| Passive smart textiles (Environment sense) | Active smart textiles (Stimulus reaction) | Intelligent smart textiles (Programmable textiles |
| Removable or attached electronics | Mixed electronics progression | Full integration of electronics |
| 2014 → | 2020 → | 2025 → |

Fabrics that can detect and respond to external environmental changes through a programmed control system, incorporating electronic logic and advanced materials. Smart textile is gaining acceptance across various industries in sensing, heating, and lighting applications.

## IV. SMART FABRIC CONCEPT IN AUTOMOTIVE LIGHTING

The below figure in next page illustrates the connection of Polymer optical fibers integrated to the geometric pattern in the fabric at one end and other to the LED controller

Polymer optical fiber (POF) is be used to create optically active textile structures by integration of weaving and electronics. Here PMMA is used as core and fluorinated polymer as cladding material for light propagation. These optical fibers are activated by special processes to achieve the lighting. The input to the POF is from 12V supply where the technology comprises with total internal reflection.

Figure 3: Polymer optical fiber connected to fabric & RGB module

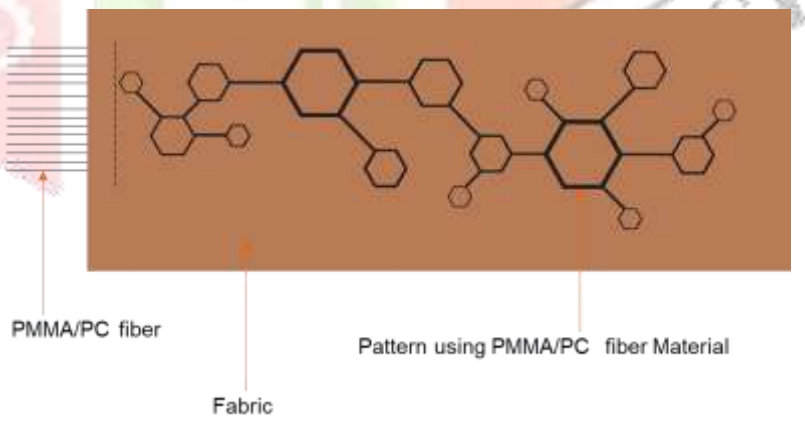



Figure 4: Polymer optical fiber property

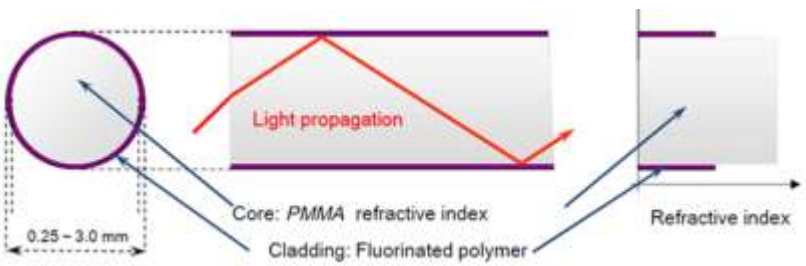
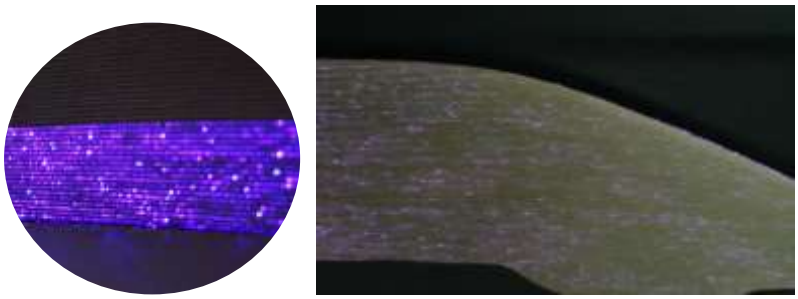


Figure 5: Lighting of polymer optical fiber (POF)

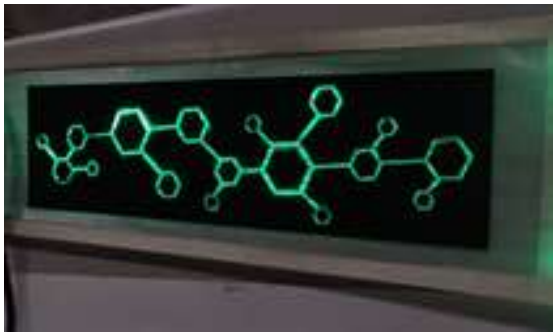


Lighting of POF creates unique experience and distinguishes the premium segment of the products. As in above figure mentioned the lighting quality is achieved in POF is better and is limited to zone or activated areas. Another important technology for this application can be EL(electroluminescent lighting )

Table 2: Technology comparison

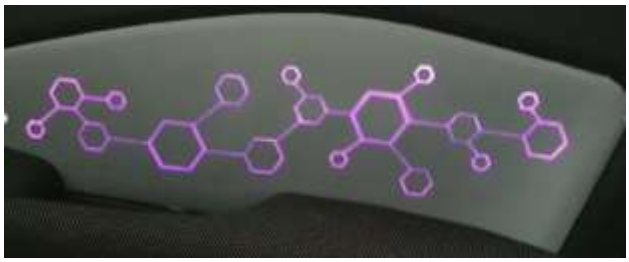
| Parameters | POF+ LED CONCEPT | ELECTROLUMINECSENT CONCEPT |
|---|---|---|
| **Integration on fabric** | Weaving& electronics integration | Screen printing multilayer & converter integration |
| **Machinery complexity for integration fabric** | High | Relatively simple- |
| **Intensity** | Slightly gradient (for long light paths) | uniform |
| **Control on lighting parameters** | Color & intensity wide range | Intensity control small range |
| **Availability** | Polymer optical fiber | Screen printing EL, Commercial grade for el applications (Not widely available) |
| **Input supply** | 12v | 12v but need to convert 100vrms@400 Hz |
| **Technology** | LED+ Total internal reflection | Light emitting capacitor |
| **Intensity variation over the time** | Not much | Susceptible to intensity change, but can be adjusted considering intensity requirements ambient lighting |
| **EMI/ EMC** | Low | High |
| **serviceability** | Serviceable for LED & Electronics, replaceable fabric in case door trim construction | Serviceable for converter & Electronics |

Figure 6: Bench level validation of fabric lighting technology



Smart fabrics is integration of illuminated surface on automotive interiors to increase attractiveness. Different geometrical patterns based on the customer needs can be made on the fabric. The POF light passes through the geometric patterns in fabric makes it feel rich. Customer can touch and feel the smart fabrics.

Figure 7: Geometric pattern in plastic fabric part



## V. SMART FABRIC UNIQUENESS & CUSTOMER BENEFIT

Proposed technology of fabrics will give an emotional connect to customer thereby increases attractiveness. Also, it improves the impression of interior space of vehicle.

Uniqueness of the technology is that multiple design patterns can be attained in same fabric. No tooling restriction other than initial set up. There are no vehicle packaging concerns as there is flexibility in packaging the LED modules.

## VI. SMART FABRICS ADVANCEMENT USE CASES IN VEHICLE APPLICATIONS

Table 3: Application and use case

| Sno | Application | Use case description |
|---|---|---|
| 1 | Ambient lighting | Mobile app-controlled illumination with predefined and custom settings |
| 2 | Hot/ cool lighting & alert | Automatically adjust the color & intensity of lighting with logic in app / addressable LED Sensing cabin temperature |
| 3 | Day night lighting | Predefined scenario on color & intensity considering human eye sensitivity day and night |
| 4 | Door open | illumination with predefined and custom settings |
| 5 | Mood lighting | Automatically Adjusting the lighting ambience by detecting driver fatigue /stress by taking relevant information |
| Colour intensity: **10 ~ 20 cd/m²** | | |

## VII. CONCLUSION

Smart fabric is a futuristic technology which provides many customer benefits and routes to an easy implementation in vehicles.

The colour & intensity of the lighting can be controlled via infotainment/mobile application. Further the evolution of proposed smart fabric will give a path towards futuristic new generation mood lighting in automobiles.

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