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Micro Fabrication and Packaging Technologies

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Abstract: Customer expectations have shifted as a result of changing and improving product variety and evolving technology. This has resulted in significant growth in the printing industry, particularly in the packaging sector. The food industry, as well as the increasing need to preserve food for long periods of time, has necessitated the development of methods for preserving the freshness and safety of food products during their shelf-life. As a result, packaging systems were given special consideration in order to facilitate food processing, preserve food quality, extend shelf-life, and keep food from spoiling. Because of these systems, packaging has evolved beyond simply acting as a barrier between the food and the environment, and has also taken on roles such as releasing protective agents or removing unwanted matter. Microbial growth is one of the most important causes of food spoilage.

Although heating, drying, fermentation, freezing, and adding antimicrobial agents have previously been tried to solve the problem, there are limitations, particularly when used with fresh food. A new generation of technologies is being introduced today to monitor the condition of products using a tiny sensor or label placed on the packaging. Smart packaging is a type of packaging that not only improves the basic functions of a product, but also responds to stimuli in its environment. Intelligent packaging and active packaging are the two main types of smart packaging. The purpose of this research is to investigate the concept of smart packaging, which has emerged as a result of increased competitiveness, digital interaction and consumer awareness, changes in consumer behaviour and expectations, and increased interest in product safety. As a result, it is obvious that cutting-edge smart packaging, which can connect to the Internet and has many channels of interaction, will create new business models and customer experiences, and will eventually replace conventional packaging, which has no interactions.

Keywords: Micro Fabrication, Packaging technology, smart packaging, intelligent packaging, smart packaging, RFID system.

I. INTRODUCTION

Scalability, high dynamic range of structures, heterogeneous integration of various components, yield robustness, and cost-saving potential are all requirements of modern PCB fabrication technologies. Polymers, as a material, meet all of these requirements and are widely used in manufacturing units. Polymers' ability to produce a large number of devices by replicating a master structure is one of their most valuable assets. Lithography-based micro-fabrication technologies are widely used for device-level applications, particularly when feature sizes and geometries are important. Polymers have been used in electronics packaging applications, particularly flexible printed circuit boards, due to material properties such as high electrical insulation, improved chemical and moisture resistance, lower weight or volume, and low dielectric constant [1-3].

Fabrication Steps:

Figure 2 depicts the fabrication steps for drawing the patterns. The procedures were nearly identical to those in, with a few changes in the controlling parameters for both laser exposure and electroless bath. The following are the sequential steps:

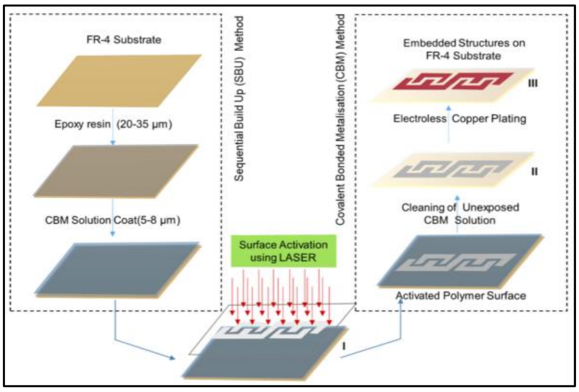

Figure 1 Process flow diagram of the fabrication steps

Step 1: Deionized water ultrasonic cleaning of the FR-4 substrate (DIW).

Step 2: Allow the FR-4 substrate to dry at room temperature.

Step 3: Spin coating the PU layer over the FR-4.

Step 4: 1 minute of UV soft baking, followed by surface hardening at room temperature.

Step 5: HP-14 spin coating on PU.

Step 6: Surface polymerization using actinic radiation and a pattern file (optional in case of bulk Cu deposition).

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Step 7: Clean the sample thoroughly with DIW to remove any unexposed HP-14 solution from the sample surface before the Cu bath.

Step 8: Cu electroless bath (Predip, Activator, Reducer and Cu bath).

Step 9: Surface characterization and final cleaning. Because the layers were sequentially built on top of each other, the fabrication process is known as Sequential Build Up-Covalent Bonded Metallization (SBU-CBM). Figure 1 depicts the proposed technique's process flow chart, in which each layer of polymer is subsequently grown and the pattern is finally metallized with Cu.

Packaging is critical for perishable products because it protects them from contamination, damage, and decay as they travel through the supply chain. Active packaging and intelligent packaging are the two main methods for improving packaging. They concluded that both methods aided in the monitoring and preservation of perishable product quality. Active packaging is a novel packaging system that either releases or absorbs substances from perishable products or their surroundings in order to preserve their quality and extend their shelf life: Previously, researchers focused primarily on active packaging; however, advances in information technology and increased demand for effective supply chain management have resulted in a shift in research focus to intelligent packaging. There is an increasing need for perishable product companies to allow more information on the product status and environmental conditions to be included inside or outside the package. As a result, there is a strong need for the development of intelligent packaging for the perishable product industry in order to improve product quality protection and reduce economic losses. [4] Intelligent packaging or smart packaging was defined as "a packaging system that is capable of carrying out intelligent functions (such as detecting, sensing, recording, tracing, communicating, and applying scientific logic) to facilitate decision making for the extension of shelf life, enhancement of safety, improved quality through the provision of information and to notify about possible problems". An intelligent package's basic functions include tracking products, monitoring the surrounding environment, and communicating with the backend system or consumers. As a result, intelligent packaging can inform consumers or food suppliers about the state of a food product and its storage environment. In addition, when an abnormal occurrence occurs, a nearly warning signal is issued [5].

Intelligent Packaging Techniques:

Various technologies have been used to develop intelligent packaging, with the goal of tracking and identifying products, monitoring product status to maintain product quality, and differentiating one product from another.

RFID is a straightforward technique for identification in intelligent packaging. The RFID reader can automatically identify physical objects in its read range by capturing radio-frequency signals remotely from RFID tags. An RFID system typically consists of an RFID tag, an RFID reader, an RFID antenna, and a backend system. The RFID tag is typically adhered to the tracked item's packaging. The cable usually connects the RFID reader and the antenna. They work in tandem to generate a magnetic field and send and receive signals to and from RFID tags. The RFID reader is capable of reading and programming the data stored on RFID tags. Figure 2 depicts an example of an RFID system.

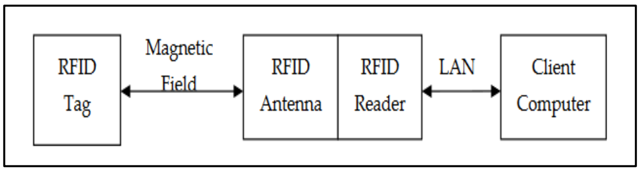

Figure 2. Schematic of atypical RFID System.

Objectives:
Researching various packaging techniques.
To ascertain the fabrication technique
Packaging design and final fabrication.

II. REVIEW OF LITERATURE

Smart packaging is defined as an active or intelligent technique that involves interactions between the package and the food (package content) or the internal gas atmosphere and meets consumer expectations for high quality, freshness, and safety (Labuza and Breene, 1989). Active packaging inhibits the growth of pathogens and destructive microorganisms, prevents the transport of pollutants, and increases shelf life while maintaining product safety and quality (Ozdemir and Floros, 2004). In other words, the packaging produced has interactive properties. Smart packaging can communicate with its surroundings in the supply chain or with the consumer. This is accomplished using at least one of the following technologies: electronic, mechanical, chemical, electrical, or online. [6-7]

Until recently, food packaging techniques contributed to the development of food delivery systems; however, these techniques are no longer capable of meeting consumers' growing demands. Traditional packaging systems have some limitations, particularly when it comes to extending shelf life and ensuring food safety. Increasing industrial use and technological advancement have increased consumer demands and shifted food industry trends in the same direction (Priyanka and Parag, 2013). While manufacturers' aim is to make sure that the packaging material keep the food fresh for as long as possible, customers want to see the freshness of the food for themselves without opening the packaging (Sü rengil and Kılınç, 2011). Consumers are becoming more picky about what they want as product variety expands. They are concerned with whether the

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manufacturing process is sanitary and hygienic. To meet rising consumer demands and industrial production trends, active and intelligent packaging systems have been developed (Lagaron et al,2004). [8-10]

III. RESEARCH METHODOLOGY

The use of the fully additive fabrication technique has been demonstrated in this paper by creating various structures commonly used in electronics. Books, educational and development journals, government papers, and print and online reference resources were among the secondary sources we used to learn about the composition, application, and impact of micro fabrication and packaging technologies.

Because of its dimensional stability and electrical properties, FR-4 was used as a base substrate in the fabrication process. FR-4 is a well-known material in the PCB manufacturing industry, and this work employs the same industrial standard commercially available FR-4. Other materials, such as FR-2, FR-3, XPC, CEM-3, and others, can also be used. When selecting the base substrate, two factors should be considered: the adhesion of the prepreg (PU/PA resins) on the base substrate's surface and the hydrophobic nature of the base material (as the electroless plating baths contain solvents)

IV. RESULT AND DISCUSSION

Figure 3 depicts the design and final fabrication results. Figure 3a depicts the inductor design, taking into account the feature sizes required for optimal inductance and Q-factor. Figure 3b shows the sample after laser patterning and cleaning. The sample was then processed in the Cu bath to metallize the tracks, as shown in Figure 3c. The black regions in the figure are caused by Cu oxidation, which can be avoided by storing the samples in an inert atmosphere. However, the goal was met by precisely building the planar spiral tracks, as shown in Figure 3d. [11]

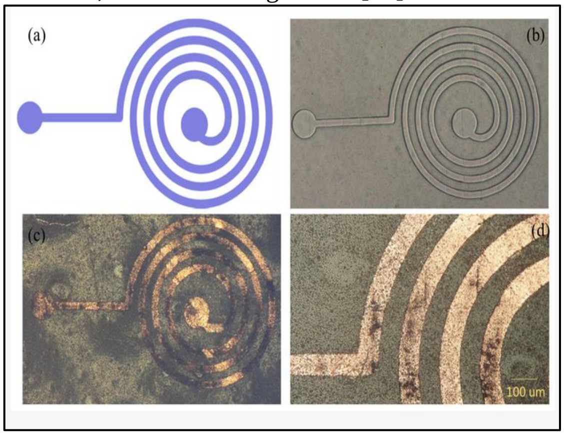

Figure 3 (a) The final optimised planar inductor design. (b) After laser surface modification and cleaning of the (c) Planar inductor pattern after the Cu bath (d) An

illustration of the fine spiral tracks created by the SBU-CBM method.

Two major aspects of the intelligent packaging system for perishable products are reviewed in this paper.

Table 1. Radio Frequency (RF) of an RFID System.

Frequency	Read Range	Data Speed	Applications
Low Frequency	0-5 cm	Low	Emergency CardAccess Control
High Frequency	10 cm–1 cm	Low to Moderate	ID CardsPayment
Ultra-High Frequency	3 m-7m	Moderate to High	Warehouse ManagementTracking
Microwave	10 m-15 m (Passive) 20 m – 40 m (Active)	High	Electronic Toll collection Container Tracking

Two major aspects of the intelligent packaging system for perishable products are reviewed in this paper. The type of applications that are best suited for an RFID system is determined by the Radio Frequency (RF). RFs are classified as shown in Table 1.

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