Manufacturing of Touch Sensors Integrated in Decorative Laminates for Furniture Surface

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Abstract

This paper reports an application example of printed electronics function on paper. We laminated printed conductive areas into a standard low pressure laminate structure on chipboard, together with a digitally printed decorative surface layer. Thus a demonstrator of customized touch sensors in furniture was realized.

Introduction

Decorative surfaces of panels for e.g. furniture or flooring is widely produced by hot-pressing one or more "décor" paper layers which beforehand are impregnated by formaldehyde melamine resin solutions and dried. During the hot-pressing, the melamine oligomers undergo further poly-condensation resulting in a hard, durable, and thermally stable "duroplastic" melamine polymer [1]. The hot pressing may be done directly on a base panel, e.g. a chip board. A product resulting from such a process is generally called "low pressure laminate" LPL and is widely used for furniture, wall panels or flooring.

In the LPL layer, the décor paper on one hand provides a fiber reinforcement structure in the duroplastic resin layer. Furthermore the décor paper provides a specific color and exhibits high opacity to hide support material, and it can be used as a print carrier for decorative images (e.g. wood design). Additionally the paper layers may be used as carrier for further functional ingredients for improving properties like wear resistance of the surface.

In the last years, dedicated décor papers were developed for digital, mostly ink jet printing. [2]. The challenge for such papers is to provide ink receiving and fixing properties while maintaining the high porosity needed for fast impregnation with the thermosetting resin solution after printing and before lamination.

By ink jet printing of inks containing conductive particles, electrical conductive patterns can be produced on paper substrates [3]. However, substrates used in this process have coatings with mesopores, which cannot be impregnated in a time efficient process with the thermosetting resin solutions after printing.

In this contribution we show that by using inkjet printing technologies, a LPL type melamine resin laminate on a chipboard base can be made which has a digitally printed decorative design surface as well an electrically conductive "hidden" pattern used as capacitive touch sensor areas for switching e.g. electrical appliance [4]. This allows the easy integration of touch functions in pieces of furniture, flooring or wall coverings.

Experimental

We prepared a low pressure laminate structure on standard chipboard with at least of two printed and impregnated décor paper layers. The printed layers were both printed on a commercial special coated decor paper "IJ Dekor" by Schoeller Technocell).

The upper merely decorative layer was printed with a graphic design using a commercial wide format printer (EPSON 4800) and the standard inks for this printed. The lower, optically "hidden" layer war printed with a conductive carbon black ink on the same paper. We achieved a layer with conductivity of the printed sensor structures of about 200 Ω/□. This area conductivity was found be well sufficient for the targeted application a touch sensor area.

Both paper layers were impregnated with melamine resin solution (KAURAMIN® 773) and cold dried.

Additional white or transparent impregnated paper layers were used a protective layers in the final laminate. Before hot pressing, the conductive pattern layer was contacted with a metallic "nail" to provide connection to the "classical" silicon chip based circuitry on the back of the chip board panel [5]. This connection points can be located at any desired place on the laminated board, giving the designer freedom to place the sensor surface and the circuitry independently. Lamination and hot pressing is done using standard equipment and processes established in the furniture industry. Pressing temperature was 140°C for 5 Minutes, leading to curing of the melamine resin.

Figure 1 shows the arrangement of the several paper sheets on the chipboard before the contacting and hot pressing step.

Figure 1. Arrangement of the printed an impregnated décor paper sheets on a chip board substrate before contacting and hot-pressing

For the printed connection lines from the sensor patches to the contact points, we used a planar "coaxial" layout. Using such a

design, we were successfully minimized any “side” sensitivity of the printed connection lines in the laminate.

The printed conductive structures (layer with the black pattern in figure 1) were connected to conventional, silicon-electronics based circuitry (MT 0.7-TX by EDISEN Sensor Systems Germany). These systems are permanently monitoring the electrical capacity of the printed conductive sensor patterns versus ground, and are sending switching radio signals when a significant capacity change is detected. Connection of the printed conductive patterns to the sensor systems were established by metallic “nails” and wire solder connections. The “nails” were placed into the chip board before hot pressing, and covered by the decorative layer and the overlay sheet. After pressing, they are completely invisible within the laminate surface. Figure 2 shows a schematic cross section of the final functional board with the integrated switching circuitry on it back.

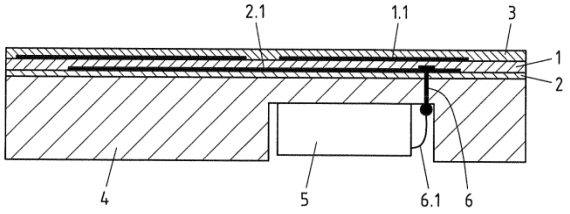

Figure 2. Cross section scheme of final functional board.
1: Decorative layer with 1.1: Decorative print;
2: Functional layer with 2.1: Conductive printed area;
3: Overlay sheet; 4: Chip board;
5: Capacitive touch switch circuitry including radio transmitter;
6: Metallic connecting (nail); 6.1: wire connection. (from [5]).

Conclusions

We constructed a demonstrator showing the integration of large area printed electronic functionality into a standard furniture, panel, or flooring laminate surface. All process steps used for its production are all well established in the laminate industry. Digital printing, preferably ink jet printing, can be used for making the conductive sensor patterns as well as for the decoration of the final surface. The process thus allows easy customization of functional furniture. The demonstration furthermore shows possible chances of digital printing for the décor industry beyond customized graphical printing.

References

[1] P. Böhme, Dekorfolien, 2nd edition, page 95 ff, Leipzig 1988.
[2] H. Schulz, and R. Gumbiowski, US Patent US 6706372 B2 1999.
[3] W. Schmidt, NIP 23 and Digital Fabrication 2007, 923 2007.
W. Schmidt, NIP 25 and Digital Fabrication 2009, 621 2009.
[4] K. Bock, and S. Schunck, Patent Application WO 2010 072332 A1 2008.
[5] W. Schmidt, German Utility Model DE 20 2014 003 058 U1 2014.

Author Biography

Wolfgang Schmidt, born 1954, holds a Ph.D. in inorganic and solid state chemistry from the University of Siegen, Germany. Presently, he is patents/IP manager at specialty paper manufacturer Felix Schoeller, Osnabrueck, Germany, also responsible for basic R&D and for R&D projects with external partners. His main focus is on imaging and printing media as well as on substrates for technical applications, e.g. printed electronics. His technological background is in the fields of paper coating, print quality, nano- and surface technology. Wolfgang Schmidt is co-director of the European chapter of IS&T.