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Verso l'economia circolare: tracciabilità dei manufatti in Compositi Fibro Rinforzati

Krožni ekonomiji naproti: sledljivost izdelkov iz kompozitov, ojačanih s steklenimi vlakni

Towards the Circular Economy: The Traceability of Fibre Reinforced Composite Products

Development of methodologies for the application and reading of RFID chips in glass fiber reinforced polymer panels

Marko Petelin[a], Davor Gombac[a], Tomaz Ceh[a], Enrico Mariotti[a], Giorgio Betteto[b]

[a] Infordata Sistemi Srl, Strada per Vienna 55/1 - 34151 Trieste (TS) Italija (marko.petelin@infordata.it)

[b] Gees Recycling, Via Monte Colombera n. 22 33081 Aviano (PN) Italija (geesrecycling@gmail.com)

ABSTRACT

The aim was to develop a methodology for application of RFID NFC (NFC Forum) and UHF (Rain RFID) chips on GFRP panels, while maintaining the board's durability and chip functionality at the end of the production cycle.

KEY WORDS

CFR panels, RFID chip, tags, circular economy, loop closing

INTRODUCTION

In line with the circular economy, especially as regards the work on closing the loop (Blomsma and Brennan, 2017), traceability of the substance enables the prolongation of substance's and product's life. In case that the economy model containing traceability and consequent reuse of the substance are used, value creation is possible (Nußholz, 2017).

The traceability of RFID-based glass fiber composite products is a challenge for Infordata Sistemi and Gees Recycling. Together, the two companies have developed a working model based on their own experiences and knowledge. Gees Recycling contributed to the waste management system and the production of panels from recycled materials, while Infordata Systemi provided traceability of the products made by Gees Recycling, based on RFID technology.

Together, we have tried to overcome two problems. The panel production process takes place at temperatures between 130 and 145°C and at pressures of about 50 atmospheres. The goal was to select those RFID chips that are strong enough to withstand these conditions, but on the other hand, inserting the chips should not cause cracks on the panel or any other physical damage to the products.

MATERIALS AND METHODS

Coworkers from Infordata Sistemi and Gees Recycling have produced several types of panels with RFID tags of different shapes and types inserted, so that tracking products throughout their lifespan was enabled.

During the technical meetings at Gees Recycling's headquarters, various tests were carried out on different types of panels with RFID chips inserted to check the strength and performance of RFID chips and panels. Various RFID chip technologies were used: UHF ISO18000 at 900 Mhz and NFC (Near Field Communication) at 13.56 Mhz (Fig. 1).

Figure 1: Images of RFID chips used for the tests (Source: SAG Technology Ltd. Taiwan chip catalog, 2019)

During the billboard manufacturing process, the temperature in the machine is between 130 and 145°C, and the pressure is about 50 atmospheres. We tested dozens of chips, with most passing the test. 80% of the chips worked after passing through the machine.

Two mixtures were used: first one consisting of glass fibers themselves and then one containing either glass fibers as well as polystyrene. The mixture in Figure 2 contains fiberglass, polyester and OMYA Alutrihydrate additive.

Figure 2: Picture of a mix with RFID chips (Infordata Systems, 2019)

The tests were conducted as follows (Fig. 3):

- The billboard maker was filled with the mixture halfway;
- RFID chips (center and edge) were placed on the mixture;
- The remainder of the mould and the chips were covered with the mixture;
- The mould was placed in a press at 130°C for about 5 minutes;
- The process was followed by tests of reading RFID chips, previously placed on the panels.

Manufactured panels with embedded RFID chips are visible in Figure 4.

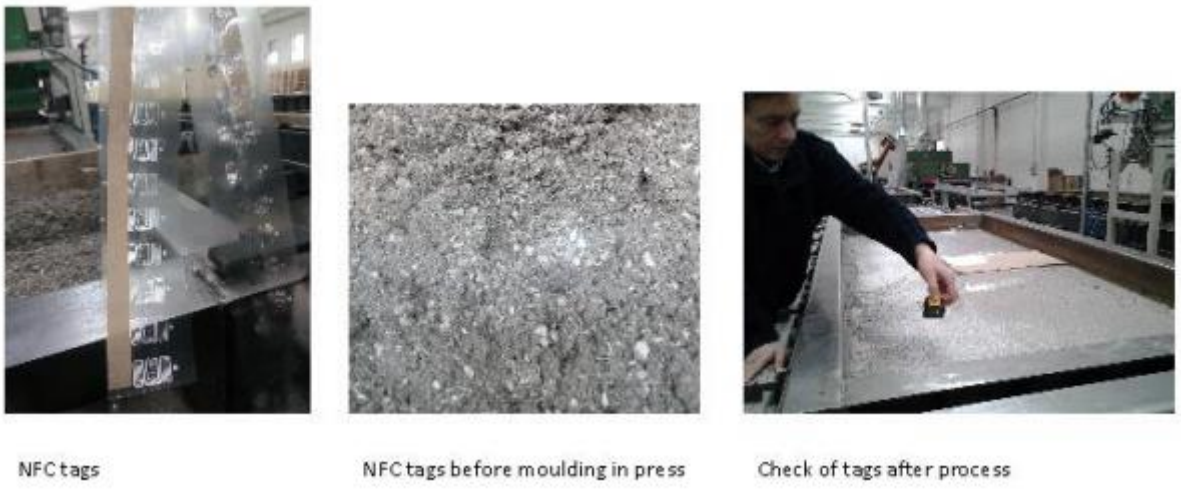

Figure 3: Layout of RFID chips for billboards (Gees Recycling, 2019)

Figure 4: Manufactured panels with RFID chips (Gees Recycling, 2019)

RESULTS AND DISCUSSION

The tests made it possible to evaluate the performance of RFID chips after processing in the press. Chips of thin thickness (<1mm) and longer length did not work after exposure to high temperature and pressure. ABS (Acrylonitrile butadiene styrene) chips, which had a greater thickness (3-5mm), caused panels to crack. Medium thickness RFID chips (1-2mm), 30mm in length, have withstood all the tests, or have worked successfully after processing in the press. The billboards' durability was thus ensured. Examples of panels for Industry 4.0 with RFID chips are shown in Figure 5 and Figure 6. RFID chips do not have magnetic elements that could impair performance over time, so they are ideal for identifying panels across the lifecycle or according to circular economy regulations until new recycling.

Figure 5: Example of panels for Industry 4.0 RFID chips for geo-localization of appliances in manufacturing facilities. RFID Sensors for Telemetry (Gees Recycling, 2019)

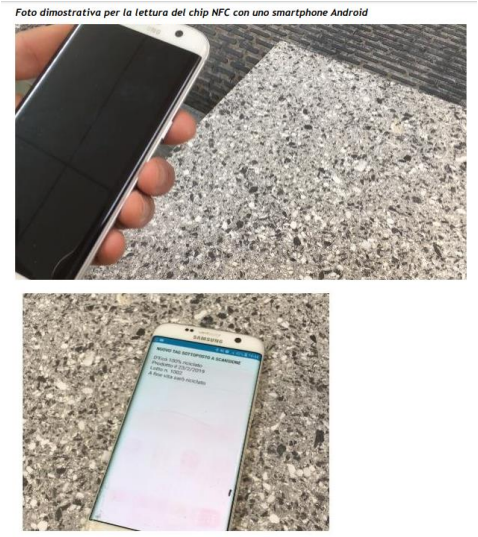

Figure 6: Billboard panels for Industry 4.0 - with built-in RFID chips for geo-localization of machines in manufacturing plants - RFID sensors for telemetry (Gees Recycling, 2019)

CONCLUSIONS

Test results have proven that the RFID chip application provides the ability to track glass fibre reinforced composite panels throughout the lifecycle, from production, sale, use, and takeover to material recovery. Infordata Systemi and Gees Recycling also based the research on the concept of "repeatability" so that the methodology of chip application and product traceability can be used in other manufacturing sectors where the chip has to be "embedded" in the material, e.g. in plastic or wooden products. Future research will allow increased use of RFID chips to identify other products, or incorporate RFID chips with sensors into materials, such as temperature or humidity measurements.

LITERATURE

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WHERE TO FIND US

W: www.ita-slo.eu/retracking

E: retracking@gzs.si (SI), enrico.pusceddu@polo.pn.it (IT)

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