Zukunft Bau

STRUKTUR / GLIEDERUNG KURZBERICHT

Titel

Langfassung Titel: „Baustoff-integrierte Flächenheizung“ – „Building material integrated surface heating“

Anlass/ Ausgangslage

The government's goal with regard to the energy policy change is to reduce CO_2-emissions and to change from today's dominant fossil fuels to renewable energies. Due to the high energy demand, heating systems for living spaces offer great potential to contribute to this goal. A wall surface heating system operated with regenerative energies and already embedded in a construction material offers a resource-saving and sustainable solution.

Gegenstand des Forschungsvorhabens

The research work consisted of applying a heating structure on surfaces in a living environment by the use of cold active atmosphere plasma and metal powder. The aim was to integrate the electric surface heating in plasterboard or alternative typical building materials and to use the printed structures as an electric resistance heating. Due to its numerous advantages, plasma coating technology was used to apply electrically conductive structures of any design to a large number of materials. By using plasma in combination with metal powder consisting of micro- and nanoparticles, permanent adhesion can be created on three-dimensional base materials. This enables the integration of a heating system directly on building material in just one step, within a few seconds. For this purpose, basic tests with different substrate materials were carried out with a variation of the parameters at the plasma coating machine. The quality of the additively applied heating structures was determined on the electrical resistance measurements of the conductor tracks as well as recordings made by a thermal imaging camera, which allowed conclusions to be made about the thermal behavior.

Furthermore, adhesion tests were carried out using a shear tester in order to judge the quality of the bond of base substrate and metallization. Based on the quality analysis, plasterboard proved to be the ideal base material for surface heating panels. Using a laser scanning microscope, the geometry and cross-section of the conductor paths produced were measured from micro sections. This enabled reliable statements to be made about the conductor path cross-section and the adhesion mechanisms that occur.

In order to investigate the long-term usability properties of the plasterboard heating structure composite, the partially wallpapered and paint coated samples were tested within a climatic chamber at a cyclical varying temperature and constant humidity. In a further test, the heating structures were heated/cooled cyclically under defined environmental conditions (fixed temperature and humidity) in order to simulate switch-on processes for a period of approx. ten years.

Another important aspect was the layout of the heating elements on the plasterboard. In the case of damages occurring on the heating structure, e.g. due to nails in the wall, the functionality of the panel heating segment has to be guaranteed through redundant design of the heating structure, which is why several layout structures were investigated. After finding optimal parameters for the coating of the building material, coating experiments were carried out on larger samples, which were also examined with regard to their specific thermal and electrical properties. After a sufficient collection of data, a simulative model of a surface heating segment was created in order to be able to calculate the required output without the need for complex experiments for a large number of other applications.

Different methods were investigated and evaluated for the electrical contacting and connection of the individual heating segments. A self-adhesive copper adhesive tape meets all previously defined requirements for an electrical connection.

As the comfort of a heating system is the most important factor besides energy efficiency, a demonstration room with a symmetrical arrangement of the surface heating systems on all enclosing wall surfaces was built. Various heating scenarios were evaluated using a comfort measuring equipment. The control of the surface heating segments could be integrated into an existing Smart-Home environment in a specially developed control system.

In order to integrate the coating system into existing production systems, the coating process was successfully integrated virtually into the manufacturing process of a prefabricated house manufacturer.

Fazit

The main objective of the research project was to develop a flexible heating system that eliminates the disadvantages of existing systems and improves the advantages of heating systems currently existing on the market. Using additive plasma coating technology, the integration of heating structures on plasterboard panels made it possible to achieve this goal. The long-term reliability of the heating system was also demonstrated under real conditions. The heating system was successfully installed inside a house, taken into operation and evaluated on the basis of various scenarios.

Eckdaten

Kurztitel: BIFH

Forscher / Projektleitung:

Gesamtkosten: 256.050,44 € €

Anteil Bundeszuschuss: 170.550,44 €

Projektlaufzeit: 24 Monate

BILDER/ ABBILDUNGEN:

5 - 7 Druckbare Bilddaten als **eigene Datei** (*.tif, *.bmp, ...) mit der Auflösung von mind. 300 dpi in der Abbildungsgröße (z.B. Breite 10 - 20cm). Bilder frei von Rechten Dritter.
Bildnachweis jeweils:
Bild 1: Plasmabeschichtungsprozess_schematisch.jpg
Bildunterschrift: Schematic representation of the plasma coating process
Bild 2: Virtuelle_Heizungsintegration.jpg
Bildunterschrift: Virtual integration of heating structures on the wall surface
Bild 3: Beschichtung_Werkstoffe.jpg
Bildunterschrift: Optical analysis of plasma-coated samples on plasterboard and alternative base substrate materials
Bild 4: Behaglichkeitsmessgerät.jpg
Bildunterschrift: Evaluation of the surface heating segments with comfort measuring equipment
Bild 5: Heizwand_Demohaus.jpg
Bildunterschrift: Real construction of the heating walls in the demonstration room