INVESTIGATIONS AND CASE STUDIES OF MICROWAVE HEATING IN PARQUET INDUSTRY

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This paper presents a new microwave accelerated process for adhesion of parquet. Parquet consists of two or three layers of wood, sandwiched together with glue. By using microwave it is possible to heat the glue directly such that the curing time for the glue can be reduced, resulting in a shorter cycle time and higher productivity.

To optimize the process one needs to know the properties of involved materials. This paper shows that the combination of wood and glue is ideal for microwave processing. To verify the capability for industrial processes, results of heating experiments at 2.45 GHz with a real microwave adapted parquet press are presented.

Using high power microwave for heating materials has several advantages compared to conventional heating. With conventional heating it is only possible to heat the surface of the material. Hence, heating the material inside its volume works only efficiently, if the corresponding heat conductivity is sufficiently high. As microwave energy couples to the volume and not only to the surface, the heating is more homogeneous.

The fabrication of parquet requires heating a thin layer of glue between two or more layers of wood. As the heat conductivity of wood is rather low, conventional heating is a time consuming process. Furthermore, there is a risk to destroy the wood by overheating. Depending on the material properties, the microwave passes through the wood nearly without attenuation and its energy gets absorbed inside the glue layer. High heating rates can therefore be achieved, resulting in a shorter curing time and higher productivity.

First, the appropriateness of the used materials for microwave heating at different frequencies is investigated. The main focus lies on the ISM frequency 2.45 GHz. Since the complex permittivity of wood depends on the sort of wood, different sorts of wood are therefore investigated. This includes oak, beech, fir, and pine, which are of special interest for the parquet industry. The complex dielectric constant for different contents of moisture is measured in a frequency range from 2 GHz to 3 GHz. Consequently, the material parameters of some brands of glue are also investigated for different temperatures and physical conditions.

An applicator was designed for integration into an existing industrial parquet press. The applicator has 6 feeding ports at the long sides. The electrical field vector is orientated tangential to the glue splice so that it is continuous at the boundary layer between wood and glue. The applicator is optimized using an FDTD simulation tool with self-consistent modeling of electro-thermal coupling. For enhanced homogeneity the inner side walls consist of a periodic structure of scattering elements with the shape of half cylinders. To put sufficient pressure on the wood die stocks of dielectric material are needed. The full paper will show the distribution of the E-field and temperature. The goal is to obtain a homogeneous volumetric heating.

To verify the results of the adhesion an experimental setup is developed with the applicator described above. A bottom layer of oak is covered with bars of fir. The glue is between these two layers. Another layer of oak is placed on top. This assay is fit in the applicator, between two slabs of Rohacell. In the experiment the applicator is fed by two microwave sources with a power of 2 kW each. The approximate pressure time is about 30 s. After the process the temperature distribution is measured with a calibrated infrared camera and the cohesiveness of the glue splice is investigated. The results will be presented in the full paper.