Preface to the COST Action FP0904

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This issue of *Holzforschung* includes a collection of papers which summarizes some of the scientific activities of COST Action FP0904 "Thermo-Hydro-Mechanical Wood Behaviour and Processing" for the period 2010–2014. The objective of the Action was to improve the knowledge on wood chemical and structural changes occurring during thermo-hydro-mechanical (THM) treatment, to better understanding the relationship between the chemical and subsequent changes in wood property, contributing to the elimination of unwanted side effects such as shape memory effect, strength loss of wood and stiffness, decrease of wood toughness and rapid aging of thermo-hydrous (TH) wood. The Action also covered topics aimed at helping to overcome challenges being faced in scaling-up of research results to industrial production and development of new processing and new products.

Today, the forestry and forestry-related industries are the focus of discussions concerning the major challenges for the future. A great challenge is to develop a sustainable society. Such a society requires the use of renewable materials, drastic reduction in the use of non-renewable natural resources and mitigation of environmental impacts such as greenhouse gas emissions. One way of reducing the emission of carbon dioxide is to increase use of wood products and improve wood longevity. This will lock up the carbon over a longer time. In addition, there is also the possibility of replacing many energy intensive materials with wood and wood products. Substituting non-renewable materials with wood-based ones is then crucial for the development of a sustainable society and new knowledge is required. The research and development of TH and THM processing for wood can be a key factor in this respect.

TH/THM processing is an old idea that has been given new life through research efforts. For centuries wood has been modified by craftsmen. It was in the 19th century that the new technological advances allowed mass production and commercializing of THM-treated wood product. One example is Michael Thonet who fabricated the "Vienna Chair" by using steam and moulding technology. Previous reviews reveal that in the 20th century a significant amount of research has been carried out in Europe and the United States on heat treatment and wood densification, though resultant properties were unsuitable, leading to a postponing for further development. Since 1980 there has been renewed interest in developing TH/THM products. Research in Japan explored surface densification of lumber, shape-transformation of round wood into prismatic shapes, fixation of shape recovery using hydro-thermal treatment. In Europe new TH/THM processing was examined, based on open and closed reactors for moulding, densification and wood heat treatment, leading to new developments. For example, in Denmark equipment for pre-compressing wood in the longitudinal direction was developed; in Germany compressed round wood has been used for manufacturing of wooden tubes, a hot open oil bath was used as the medium for eliminating the set-recovery of large industrial densified wood; in France and in Switzerland the joining of wood by means of friction welding was developed. In the USA and Canada wood researches have shown interest in densification of fast grown, low density wood for use in construction of layered composites. The activities of and the new knowledge resulting from COST Action FP0904 is further evidence of renewed research interest in TH/THM processing.

New TH/THM treatments are implemented to improve the intrinsic properties of wood, to produce new kinds of materials, and to acquire a form and functionality desired by engineers without changing the eco-friendly nature of the wood. In this technology, the modification of mechanical properties, dimensional stability, resistance to micro-organism, change of color and odor are consequences of chemical and structural changes of wood constituents. There are also undesired side effects, such as loss in strength and fracture toughness and, in particular compression-set recovery which will need to be addressed in the future. There are the challenges being faced in scaling-up of research findings as well as improving the characteristics of full industrial productions. It is important to understand the chemical changes that occur in wood during THM/TH treatments and predicting the performances of the product on the basis of a broad array of processing parameters, wood species and wood dimension.

The contributions in this issue of the journal provide state-of-art-review papers covering three principal research areas carried out over 4 years of the Action FP0904 activities: Chemical transformation of wood components under Thermo-Hydrous treatments and characterization of TH wood properties, Wood behaviour during THM processing and prediction of the THM wood properties using mathematical modeling, and new emerging products of THM processing by an open system.

Investigation of these phenomena required close collaboration between groups from different wood disciplines from academia and industry. These papers identify those questions which remain unanswered. This should stimulate additional multi-disciplinary research efforts, basic and applied, to achieve the level of understanding that the subject deserves.

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