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DEVELOPMENT AND DEMONSTRATION OF HIGHLY INSULATING, CONSTRUCTION MATERIALS FROM BIO-DERIVED AGGREGATES

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The ISOBIO project will develop a new approach to insulating materials through the novel combination of existing bio-derived aggregates with low embodied carbon and with innovative binders to produce durable composite construction materials. These novel composites will target 50% lower embodied energy and CO_2 at component level and 20% better insulation properties than conventional material. The project will also seek to demonstrate a reduction of at least 15% in total costs and 5% total energy spent over the lifetime of a building. ISOBIO started by identifying promising organic materials that could be used as insulation. Many of these are classified as waste or by-products of processes like food production. Finely chopped bio-materials such as hemp and straw are treated with hygrothermal resins and nano- particles that make them robust, breathable, moisture resistant, and fire retardant. The bio-aggregates are typically the result of combining organic and inorganic materials; the organic material may have natural insulating properties, for example, while the inorganic material may make the resulting bio-aggregate more robust. Combing organic materials with inorganic materials is not always easy, however. Hemp, for instance, is being combined with lime mortar but the two materials have a degree of chemical incompatibility which could result in a reduction in the strength of the composite material. To overcome this challenge, ISOBIO's researchers are using nano-technology to increase the interfacial strength between the two materials, giving the resulting composite material improved mechanical and structural properties. The new materials not only improve upon the performance of conventional materials, they also offer new features. Hemp shiv, which is the core of the hemp stalk, for example, has a porous structure that provides moisture buffering to maintain humidity at a more constant level. While the new composite materials may provide more comfort, they need to be at least as robust as conventional materials. To make the hemp-based bio-aggregate water repellent, for example, ISOBIO's researchers are applying hydrophobic treatments to it. The result is that water vapor can travel in and out of the material but liquid water cannot penetrate it. TWI is exploring the development of novel inorganic-organic hybrid nano-materials, to be applied as a surface treatment onto bio-based aggregates. These nanoparticles are synthesized by sol-gel processing and then functionalized with silanes to impart multifunctionality e.g. hydrophobicity, fire resistance and chemical bonding between the silica nanoparticles and the bio-based aggregates. This talk will illustrate the approach taken by TWI to design the functionalized silica nanoparticles by using a material-by-design approach. The formulation and synthesize process will be presented together with the challenges addressed by those hybrid nano-materials. The results obtained with regards to the water repellence and fire resistance will be displayed together with preliminary public results of the ISOBIO project.

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