Femtosecond Laser Processing of Basalt for Carbon Negative Cementitious Materials

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A critical need for the decarbonization of the built environment is the development of carbon-negative cementitious materials. This poster introduces the innovative use of femtosecond laser processing of basalt, a common but unreactive volcanic rock, to develop novel cement alternatives to portland cement—which accounts for 6-8% of global CO₂ emissions. More specifically, the ultrafast heating and cooling provided by the femtosecond laser creates a defective state in basalt necessary to enable binding and workability (critical qualities of cements) through improved reactivity in water. Seven parameters in the laser processing have been identified as having possible effects on the basalt atomic structure via scanning electron microscopy with an energy dispersive spectrometer. Preliminary results demonstrate melted areas with significant elemental movement in silicon, calcium, and oxygen. This elemental movement demonstrates important changes in the atomic structure (i.e., melt) rather than returning to the original structure after re-solidification, providing the possibility of defects. If successful, the production of defective basalts has the unique potential to create basalt-based cements for the first time and eliminate and convert our built infrastructure from a primarily carbon emitter to an innovative carbon sink.