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Biomimetic, programmable, and self-healing composite for mitigating gas/liquid leakage in wellbores

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Along with significant incentives to extract oil and gas from deep and unconventional resources, significant challenges exist in developing advanced technologies while being environmentally responsible. In this context, wellbore leakage and plugging is one of the key concerns that can affect both performance and environment. A similar leakage issue also relates to underground carbon storage sites. Inspired by the delicate architecture of natural materials, herein we present a bottom-up synthesis and design of a strong, tough, and self-healing composite using simple but universal spherical building blocks. Our product consists of inorganic porous nanoparticle loaded with desired sealant material which, upon exposure to heat or other stimuli, releases into the natural gas and fluid channels that are contained in the wellbore structures, effectively creating a barrier for escaping gas/liquid. The porous nanoparticles have unprecedented monodispersity on particle size, particle shape, and pore size, which facilitate their packing and performance including effective loading and unloading. This work paves the path towards fabricating a novel class of biomimetic composites using low-cost spherical building blocks, potentially impacting several areas including remedial and primary well cementing.

References

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