Microwaved nanoribbons may bolster oil and gas wells

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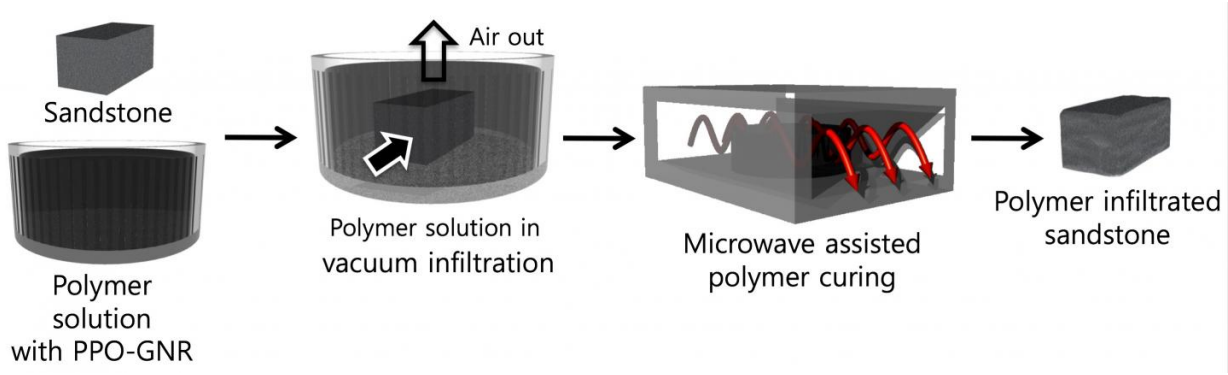

Rice University researchers have developed a method to treat composite materials of graphene nanoribbons and thermoset polymers with microwaves in a way that could dramatically reinforce wellbores for oil and gas production. Credit: Nam Dong Kim/Rice University

Wellbores drilled to extract oil and gas can be dramatically reinforced with a small amount of modified graphene nanoribbons added to a polymer and microwaved, according to Rice University researchers.

The Rice labs of chemist James Tour and civil and environmental engineer Rouzbeh Shahsavari combined the nanoribbons with an oil-based thermoset polymer intended to make wells more stable and cut production costs. When cured in place with low-power microwaves emanating from the drill assembly, the composite would plug the

microscopic fractures that allow drilling fluid to seep through and destabilize the walls.

Results of their study appeared in the American Chemical Society journal *ACS Applied Materials and Interfaces*.

The researchers said that in the past, drillers have tried to plug fractures with mica, calcium carbonate, gilsonite and asphalt to little avail because the particles are too large and the method is not efficient enough to stabilize the wellbore.

In lab tests, a polymer-nanoribbon mixture was placed on a sandstone block, similar to the rock that is encountered in many wells. The team found that rapidly heating the graphene nanoribbons to more than 200 degrees Celsius with a 30-watt microwave was enough to cause crosslinking in the polymer that had infiltrated the sandstone, Tour said. The microwave energy needed is just a fraction of that typically used by a kitchen appliance, he said.

"This is a far more practical and cost-effective way to increase the stability of a well over a long period," Tour said.

In the lab, the nanoribbons were functionalized—or modified—with polypropylene oxide to aid their dispersal in the polymer. Mechanical tests on composite-reinforced sandstone showed the process increased its average strength from 5.8 to 13.3 megapascals, a 130 percent boost in this measurement of internal pressure, Shahsavari said. Similarly, the toughness of the composite increased by a factor of six.

"That indicates the composite can absorb about six times more energy before failure," he said. "Mechanical testing at smaller scales via nanoindentation exhibited even more local enhancement, mainly due to the strong interaction between nanoribbons and the polymer. This,

combined with the filling effect of the nanoribbon-polymer into the pore spaces of the sandstone, led to the observed enhancements."

The researchers suggested a low-power microwave attachment on the drill head would allow for in-well curing of the nanoribbon-polymer solution.

More information: Nam Dong Kim et al, Microwave Heating of Functionalized Graphene Nanoribbons in Thermoset Polymers for Wellbore Reinforcement, *ACS Applied Materials & Interfaces* (2016). DOI: 10.1021/acsami.6b01756

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