# REVOLUTIONARY BUILDING MATERIALS

# ORAL TESTIMONY

Testimony before the House Committee on Science, Space and Technology, Subcommittee on Energy, hearing on "Building Technologies Research for a Sustainable Future"

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I am a professor of Chemistry, Materials Science and NanoEngineering at Rice University, and part of the Welch Institute for Advanced Materials.

- I have 730 research publications; 234 of those being on the topic of graphene.
- I have over 50 U.S. plus 90 international patents on graphene.
- In the past 6 years alone, my academic research has led to the formation of 14 companies, 8 of those in nanomaterials, and two of them now public companies.

On March 15, 2017, I gave testimony before the Energy and Commerce's Subcommittee on Digital Commerce and Consumer Protection on the topic of graphene and attaining US preeminence. Four years later, I'm here to report that the future has arrived.

What is graphene? Think of it as carbon chicken-wire! That's what it looks like, chicken-wire, in its atomic arrangement, but on the one-atom-thick scale. Graphene is a nontoxic naturally occurring carbon material and its agglomerates are the natural mineral graphite. It is very slow to enter the carbon dioxide cycle and hence it can be considered a terminal carbon sink with near-zero contribution to greenhouse gas emissions.

Graphene is a revolutionary material for building construction, but until recently, affordability and access to sufficient quantities made it only a dream for those applications. In 2018, a graduate student in my laboratory, Duy Luong, working under funding from the Air Force Office of Scientific Research, discovered a process that we call "flash graphene". We immediately filed patents to protect the technology and companies were formed one year later: Universal Matter Inc. and Universal Matter Ltd. The process can take any carbon material—any carbon material—and converted it into graphene in less than one second using only electricity; no water, no

solvents, and no additives other than carbon itself. This new graphene manufacturing process will lower the cost by a factor of 10 thereby making it economically viable for use in building materials.

The majority of waste products generated by human beings are carbon-based. If it's not rocks or water, it's probably carbon. We can take coal, petroleum coke, unsorted plastic waste, discarded food, mixed household waste, or any other carbon source and convert it into graphene. Our production rate is doubling every nine weeks, thereby projecting to the hundreds of tons per day scale within three years. With grants from the Department of Energy and the Department of Defense, and in collaborations with the Army Corps of Engineers (ERDC), Argonne National Laboratory, Pacific Northwest National Laboratory, and several large automotive, concrete, asphalt and wood manufacturers, we are developing graphene for concrete, asphalt, steel, aluminum, plastics, polymer-foams, lubricants, rubber, wood, fabric and paint composites.

By adding just 0.1 wt% to cement, we get a 35% enhancement in the compressive strength. It means we could use one third less cement for construction. And since cement and concrete constitute 8% of all worldwide carbon dioxide emissions, that could translate into a remarkable diminution of emissions. Concrete alone is a $30 billion new market opportunity for graphene. 0.5 wt% addition of graphene to asphalt will triple the life of the road. 0.05 wt% of graphene to carbon fiber composites will lower the weight of an aircraft by 20% translating into enormous fuel and carbon dioxide reductions. All made possible by this US invention.

Through Rice University's Carbon Hub, we are developing methods to convert natural gas into hydrogen and graphene with near-zero carbon dioxide emissions. That's clean hydrogen fuel from natural gas.

The next step is to develop entirely new classes of graphene composites that can substitute for the energy intensive 2500-year-old materials that we use today, like concrete and steel, while providing a non-toxic carbon sink for most human waste products.

**The take-away from this testimony:**

**First:** Continue to foster support of basic and applied research directed toward the advancement and deployment of new materials. A few years ago, graphene was only viewed as appropriate for ultra-high-end aerospace and device applications, but not anymore. The bipartisan Endless Frontier Act could embody an interesting approach to achieve the requisite research and translational goals.

**Second:** It remains challenging to go from the lab-bench to the build-site with market profitably. Congress has immense power and influence over tax policy and administrative and regulatory burdens that can make or break our start-up companies.

**Third:** Streamline the Green-Card process for scientists and engineers that have received their PhDs in the US, so that people like Duy Luong, the Vietnamese graduate student that discovered the flash graphene process in my laboratory, can stay to develop their discoveries in our nation's companies.

Thank you.