

## LABORATORY/SCIENCE CHALLENGE:

Stronger, lighter-weight, multifunction material via superior nanomaterials:  
*A better nanotube ...* overcome disappointments of over-hyped carbon nanotubes (CNT).

## TECHNOLOGY SOLUTION: **BORON NITRIDE NANOTUBES (BNNT)**

- BNNT is the strongest material on earth, yet lightweight; inorganic & non-toxic; thermally conductive but electrically insulating; less reactive than CNT and thermally tolerant well beyond CNT.
- Theory & Discovery of BNNT at DOE's Lawrence Berkeley National Lab.
- Invention at **Jefferson Lab** of scalable, and higher purity/quality (with no catalyst), advanced manufacturing method for BNNT – in collaboration with NASA-Langley Research Center and National Institute of Aerospace – via **Free Electron Laser (FEL)** funded by US Navy's Office of Naval Research (ONR).

## APPLICATIONS:

- Strong, lightweight structures – composite with metals, ceramics, and polymers to make stronger, survive higher temperatures, etc.
- Extreme surfaces – vibration damping at extremely low and high temperatures, cryopump adsorbent, catalysis beds, neutron shielding/detection, quantum computing
- Thermal management – extract heat from deep within electronic circuits, without risking electrical short, to improve performance of electronics

## INDUSTRY PARTNER:



- BNNT Materials company formed in Newport News, Virginia to commercialize this revolutionary new material

## RESULTS:

- NASA ***Invention of the Year***, awarded in NASA Centennial Celebrations 2017
- USG funding awards: SBIR from Navy, SBIR from DOE, multiple BAAs from Navy
- DOE Cooperative Research & Development Agreement (CRADA)
- NASA Space Act Agreement; Multiple elite university partnerships
- International commercial company partnerships; Commercial sales
- 3D-printed with steel → made steel 3x harder; titanium 2x harder; aluminum 4x stronger; fiberglass 34% tougher, 20% more flexural toughness, 15% stronger lap shear
- Plastics ~50x more conductive of heat