National Aeronautics and
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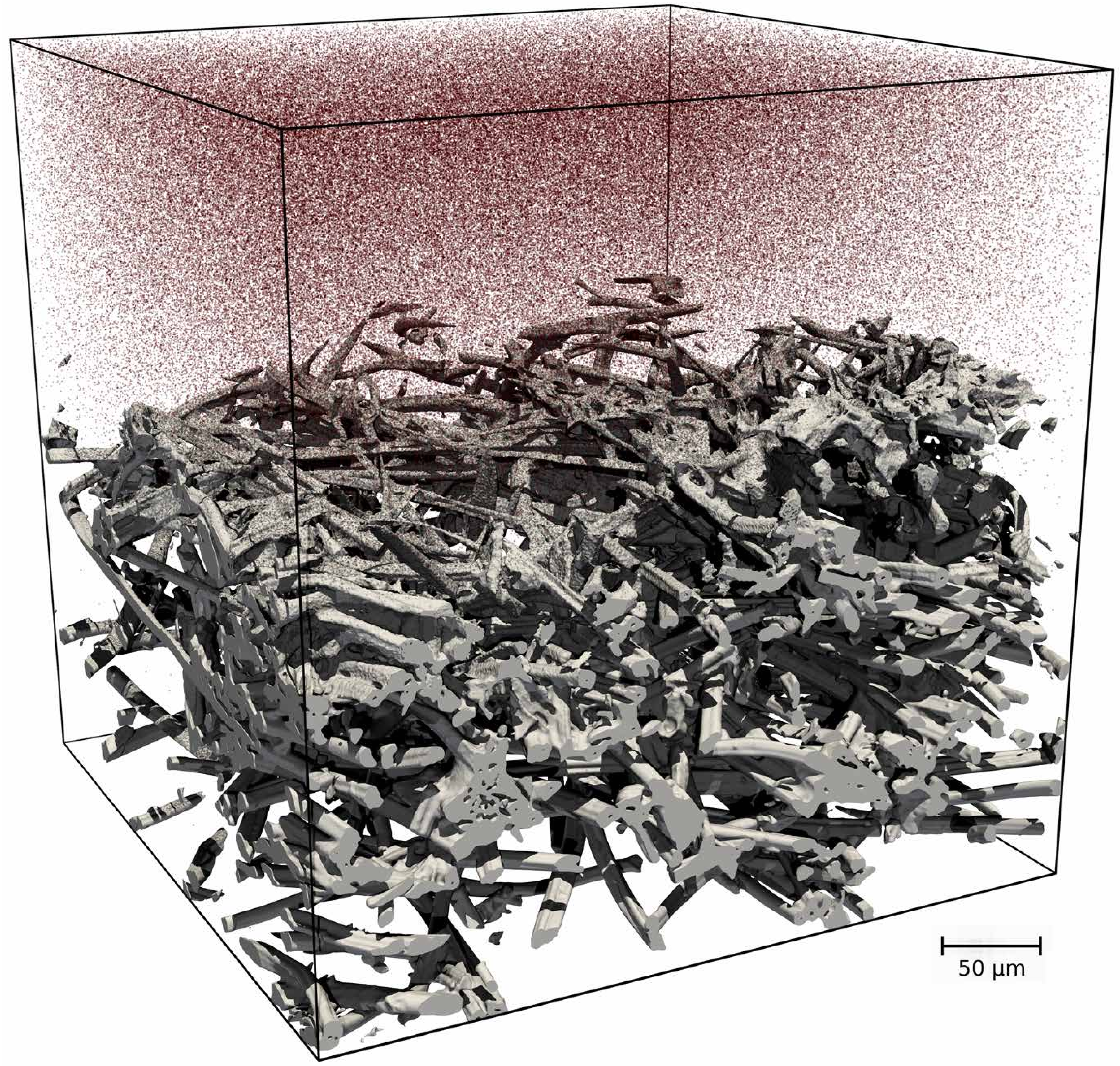


Frame from a simulation showing microscale ablation of a heat shield due to oxidation. Particles enter from the top and react as they collide with the microstructure of the material. As the simulation progresses, the surface material is eaten away, allowing the particles to diffuse further downward. The material represented here is the carbon fiber precursor to the Phenolic Impregnated Carbon Ablator (PICA), invented by NASA for use in spacecraft heat shields. *Joseph C. Ferguson, NASA/Ames*

# Microscale Analysis of Spacecraft Heat Shields

Imagine entering Earth's atmosphere after returning from the outer solar system. A heat shield less than 2 inches thick protects you from temperatures up to 2,900° Celsius (5,252° Fahrenheit). Such conditions were experienced by NASA's Stardust capsule during reentry in 2006. The only materials capable of providing the necessary protection are composites with complex microstructures. Evaluating these materials is difficult, requiring precise knowledge of their properties. To this end, NASA scientists are developing research codes to compute material properties and simulate ablation at the microscale using agency supercomputers. Utilizing these tools, along with experiments, researchers are working to push the limits of spaceflight, allowing for greater flexibility in future space missions.

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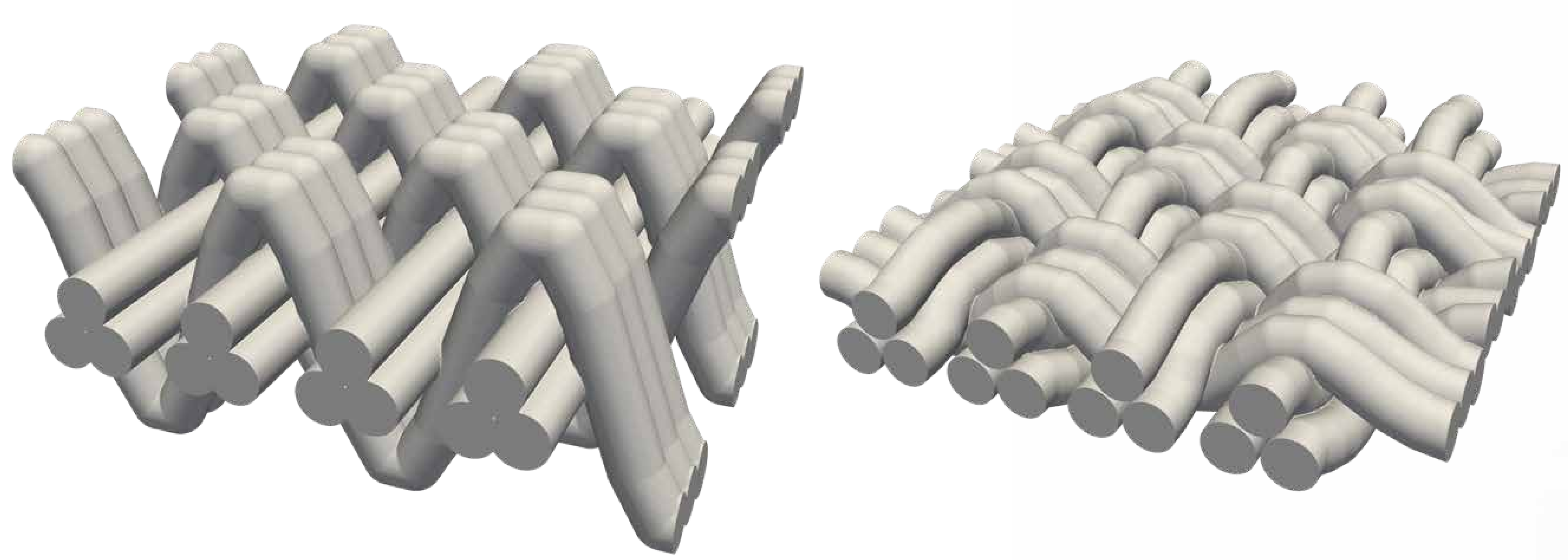

Images showing the stretching of a woven material. The microstructure shown on the left was generated computationally using parameters from a weave diagram. Stretching of the weave was then simulated to produce the more realistic microstructure shown on the right. NASA is currently investigating such woven materials, due to their heat resistant properties and ability to be customized for use in future spacecraft heat shields. *Sander J. Visser, John M. Thornton, NASA/Ames*

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