



## TECHNOLOGY SOLUTION

### Mechanical and Fluid Systems



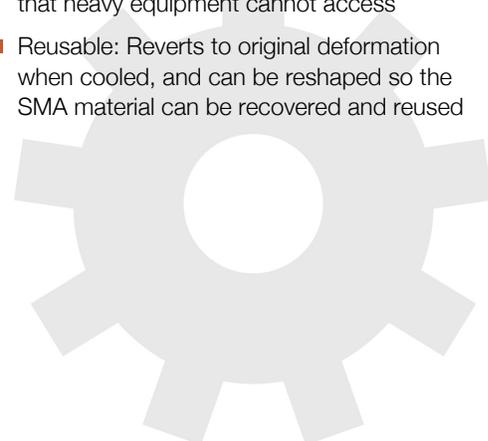
# Shape Memory Alloy Rock Splitters (SMARS)

Provides a compact, powerful, non-explosive method for fracturing rocklike materials

NASA's Glenn Research Center have developed a groundbreaking method for using shape memory alloys (SMAs) to split apart rock formations without explosives or hydraulics. Conventional approaches present difficulties in transportation and operation and can badly damage underlying samples during use. Glenn's innovation exploits cutting-edge SMA compositions to deliver controllable stresses in excess of 1500 megapascals (MPa), which is up to four times greater than the force exerted by commercial equiatomic SMAs. The SMA compositions are also tunable to multiple activation temperatures up to 400°C, depending on the usage environments. Glenn's Shape Memory Alloy Rock Splitters (SMARS) device generates this power without any demolition damage to the surrounding environment, and in a package that combines reliability, ease of setup and activation, and cost-effectiveness. This technology could prove invaluable to enterprises as varied as oil drilling, mining, civil engineering, fossil collection, and search-and-rescue operations - any field that requires compact, but large, static forces.

#### BENEFITS

- **Powerful:** Produces stresses that are four to five times more powerful than commercial equiatomic nickel-titanium (NiTi) alloys generate
- **Controllable:** Causes no demolition or vibration damage to the surrounding environment or other nearby projects
- **Convenient:** Needs little setup and activation compared to other static methods, such as chemical agents, which can take days to react
- **Simple and safe:** Requires only heat input to activate no complex valve systems or hydraulic fluids are needed
- **Compact:** Has small volume and extremely low weight, so it can be transported more easily than heavy hydraulic wedges, explosive materials, or chemicals
- **Versatile:** Features portability and setup advantages that allow it to be used in spaces that heavy equipment cannot access
- **Reusable:** Reverts to original deformation when cooled, and can be reshaped so the SMA material can be recovered and reused



## THE TECHNOLOGY

Glenn's revolutionary SMARS device is fabricated from nickel-titanium-halfnium (NiTiHf), nickel-titanium-zirconium compositions, or a combination. These compositions contain a secondary, nanometer-sized precipitate phase, which is produced through processes of compositional control and ageing heat treatments. Glenn's novel materials and processes have yielded a SMA composition that produces much higher stresses than other SMAs on the commercial market.

The SMARS device is composed of 1) SMA material as the actuating member; 2) a casing heater placed around the SMA member; 3) a DC or AC power source to provide current through the heater; 4) pointed tips for acute penetration into rock formations; and 5) a hand-press to reset the SMA element after each use. In the rock-splitting process, a hole equal to the diameter of the SMA element is drilled in the portion of the rock where the fracture is desired. Next, the pre-compressed SMA is inserted into the hole, and AC or DC current is applied to energize the devices heaters. Once the heater achieves the critical transformation temperature, the SMA will begin to expand within seconds. Since its expansion is constrained by the rock walls, the SMA will eventually exert up to 1500 MPa of stress, splitting the rock apart. When the current is removed and the heater cools, the SMA material returns to its pre-compressed state. At this point, the material can be recovered, so the process is repeatable after reshaping. The SMA actuating members were also designed to achieve displacement greater than the materials strain output. Glenn's SMARS device provides high-powered rock fracturing that is controllable, reliable, and comparatively simple without the use of explosives, hydraulics, or chemicals.



Glenn's SMARS device is ideally suited to break up rock formations as part of oil and gas drilling projects



The SMARS splits rock formations without the use of explosives or chemicals, greatly increasing control and reducing unwanted damage

## APPLICATIONS

The technology has several potential applications:

- Oil and gas
- Hydraulic fracturing
- Mining (gemstone, precious metal mining)
- Archaeology
- Search and rescue
- Commercial space
- Civil Engineering
- Search and Rescue

## PUBLICATIONS

Patent No: 9,649,780; 10,675,781

Patent Pending

[technology.nasa.gov](http://technology.nasa.gov)

More Information

National Aeronautics and Space Administration

**Agency Licensing Concierge**

**Glenn Research Center**

21000 Brookpark Road

Cleveland, OH 44135

202-358-7432

Agency-Patent-Licensing@mail.nasa.gov

[www.nasa.gov](http://www.nasa.gov)

NP-2017-07-2432-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-19195-1, LEW-19195-2, LEW-19195-3, LEW-TOPS-122