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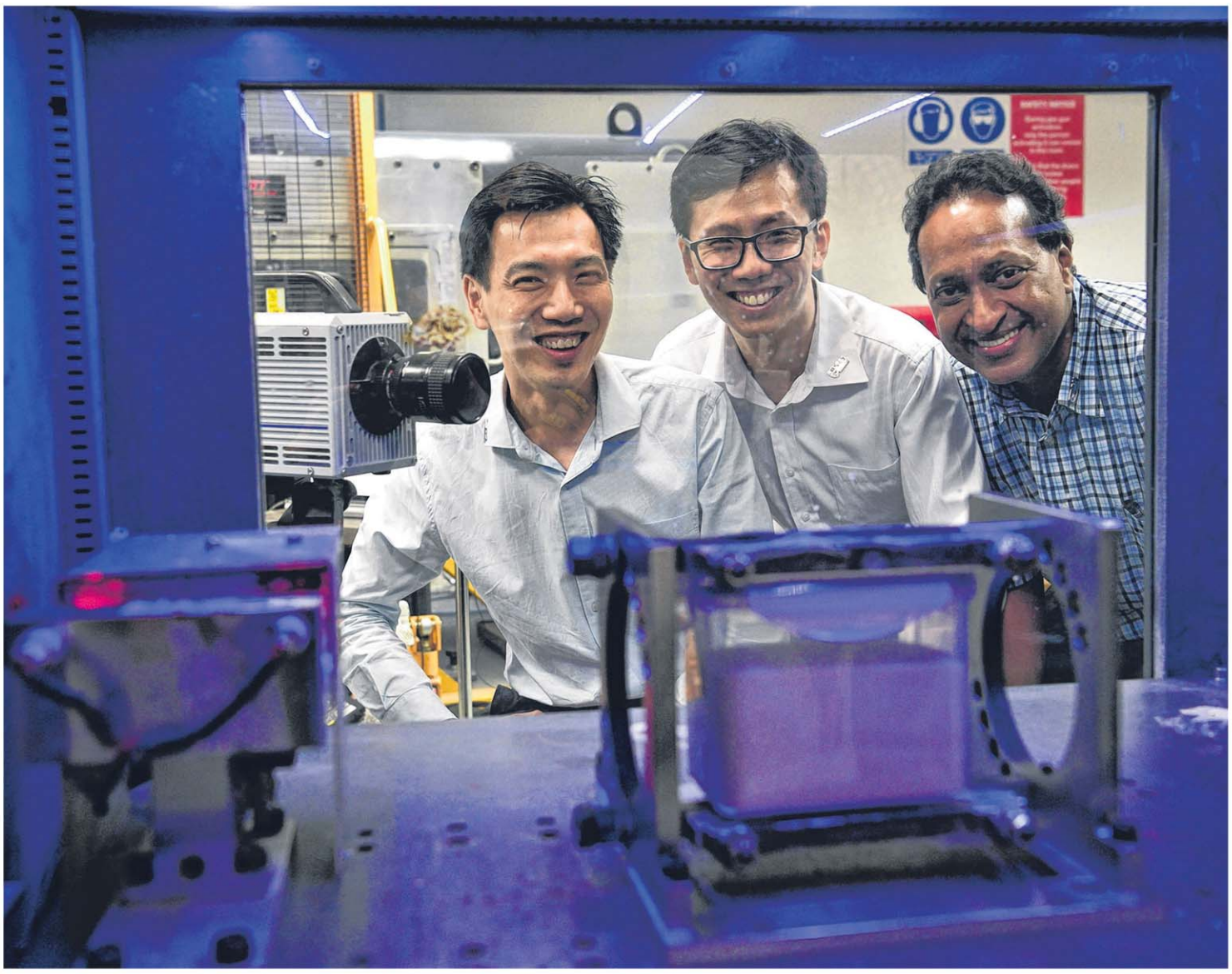

NUS professors (from left) Vincent Tan, Darren Chian and Anand Sarma with a machine used to test the ability of sand to absorb energy exerted on it. Steel would melt on impact if hit by armour-piercing ammunition shot from a high-velocity rifle. In contrast, sand would actually break up the bullet. ST PHOTO: MARK CHEONG

When grains of sand are stronger than steel

Ability to resist impact makes sand a low-cost option for use in defence, NUS study shows

Samantha Boh

Sand could be an untapped defence resource, according to researchers here.

A team from the National University of Singapore (NUS) has found that sand can absorb more than 85 per cent of the energy exerted against it.

More intriguingly, its ability to resist impact increases with the speed of the incoming projectile making the impact, even at high velocities, said Assistant Professor Darren Chian from the Department of Civil and Environmental Engineering.

As a result, sand could be harnessed to lessen bomb damage, or improve the fire resistance of doors and building structures.

Prof Chian said that even though the substance has traditionally been used for military fortification in times of war, in the form of sand bags, little is known about its unique ability to absorb energy.

"There is still a lack of detailed understanding about how it works to resist impact, and how this resistance changes with the speed and geometry of the incoming projectile," he said.

"Our findings show that sand holds strong potential as a composite material for protection against impact."

This could mean placing compacted sand blocks on the building columns of critical infrastructure to protect it from a blast.

In addition, steel – one of the key materials used in the construction of armour systems – could be partially replaced with sand as a cost-effective, environmentally friendly "sacrificial layer", noted Prof Chian.

The team behind the NUS study includes Associate Professor Vincent Tan from the Department of Mechanical Engineering and Adjunct Assistant Professor Anand Sarma from the Department of Civil and Environmental Engineering.

As part of the 1½-year study, five types of projectiles weighing from 7g to 20g were fired into a container of sand sealed with a vacuum-tight cover and secured with bracket frames.

The sand block was able to absorb at least 85 per cent of the energy exerted on it.

The pressure and friction offered by the sand grains, which dilate and resist continual penetration by the incoming projectile, also gave the sand the ability to break the projectile into pieces, said Prof Chian.

Comparing sand and steel in terms of their energy-absorption ability, Prof Chian said steel offers stronger resistance at low-impact velocities of less than 600m per second – comparable with a bullet shot from a handgun.

But at velocities beyond 2.5km per second – comparable with armour-piercing ammunition shot from a high-speed rifle – steel melts on impact, while sand is able to disintegrate the bullet.

The NUS team will be running larger trials to further study the ability of sand to resist impact, as well as starting research into the energy-absorption capabilities of similar materials such as rock rubble.

Dr Chan Chin Loong, a lecturer at Singapore Polytechnic's School of Architecture and the Built Environment, said the NUS research will spark interest.

"Apart from military applications, these novel findings could perhaps also extend the usage of sand as a protective material to civil defence shelters in residential units and MRT stations, or play a part in defending some of our key installations in the event of a terrorist attack," he said.

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