SUCCESS STORY

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DEPARTMENT OF THE AIR FORCE
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LOW-COST, THREE-PATENT BREAKTHROUGH IS MORE THAN MEETS THE EYE

Wright-Patterson AFB, DAYTON – It may take an inventor their entire career to earn a patent. But, for others, patents come in bunches as has been the case for Air Force Institute of Technology (AFIT) engineer Hengky Chandrahalim, PhD and his team. Their work in sensors led to fabricating an improved Fabry–Perót (FP) cavity, which was achieved with a combination of three patents. The team have developed a quick, simple, and comparatively inexpensive process through this work.

The patents, “Temperature-immune self-referencing Fabry–Pérot cavity sensors” (U.S. Patent #10,942,313B2), “Method of making temperature-immune self-referencing Fabry–Pérot cavity sensors” (U.S. Patent #11,156,782B2), and “Temperature-immune self-referencing Fabry–Pérot cavity sensors” (U.S. Patent #11,204,468B2), involve the use of a Fabry–Pérot interferometer.

The FP cavity is a tool first developed in 1899 by Charles Fabry and Alfred Perót to determine optical resonance.

“It’s an optical device we can use to trap light of a specific wavelength,” Chandrahalim explained. “Traditionally, people used the FP cavity, which features a pair of parallel, highly reflective mirrors to allow a small amount light of a particular wavelength to pass through. These are separated by a certain distance, which is usually implemented on a very large optical table. When the light of a certain wavelength is trapped in this device, it corresponds to an integer multiple of the separation between the two reflective mirrors. It is here where we can observe optical resonance. The optical resonance can be used to sense different physical phenomena.”

However, what Chandrahalim and his team, made up of mostly AFIT engineers – with assistance from two researchers from the Air Force Research Laboratory (AFRL), have developed is an improvement on this device that they believe will lead to many uses. They implemented a two-photon polymerization process fabrication technique that is quick, simple, and inexpensive compared to traditional microfabrication methods. This makes it easier for rapid prototyping and offers the ability to adapt to new requirements. These devices also allow for true 3D design freedom, which can shape microscale optical elements in typically difficult geometries and is able to detect thermal radiation.

“Using this (improved method), we are able to shrink this optical system to a much smaller area,” Chandrahalim said. “It can be miniaturized and integrated into our existing technology. We always want to improve the power and performance of our devices. In many applications we have stringent, spatial requirements. With this technology, we can integrate high-performance sensors easily to our existing technology.”

TECH SNAPSHOT

PATENT NUMBERS:
US 10,942,313B2
US 11,156,782B2
US 11,204,468B2

TECHNOLOGY NAMES:

- Temperature-immune self-referencing Fabry–Pérot cavity sensors
- Method of making temperature-immune self-referencing Fabry–Pérot cavity sensors
- Temperature-immune self-referencing Fabry–Pérot cavity sensors

INVENTORS:
Dr. Hengky Chandrahalim and his team

TECHNICAL PROJECT OFFICE:
Air Force Institute of Technology (AFIT)

SOURCE:
US Patent and Trademark Office
www.uspto.gov

While the team is optimistic this device can be of valuable use to the Department of Defense and the warfighter in things like aircraft and microsatellites, they also see a large potential in the commercial sector.

"This would be good for many different things. For example, a sensor monolithically integrated onto an optical fiber, employed within the medical industry, can be utilized internally within the human body to detect various diseases and viral infections," Chandrahalim said.

He also sees the 3D FP cavity arrays as powerful scientific allies, providing real-time insights into natural disasters and offering predictive measures of their impending severity.

"In the realm of detecting seismic events such as earthquakes or tsunamis, the portable FP cavity transforms into a high-precision seismometer. When such a force of nature manifests, it triggers a movement in the ground, consequently causing displacement in a mirror constituent of the FP cavity. This device is used to attract a certain light with a particular wavelength. An earthquake or tsunami is going to produce a large amplitude of mechanical waves."

While all this sounds very impressive, Chandrahalim and his team aren't finished yet. They continue to work on improving the 3D FP while searching for more ways to apply it for the DoD and beyond. Chandrahalim encourages his fellow innovators to not be afraid of research and data coming from areas that may be foreign to them.

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Dr. Hengky Chandrahalim
AFIT