Scientists uncovers an exciting use of Teak leaf which offers a natural, biodegradable laser shield towards protecting delicate optical devices and human eyes from high-power laser radiation

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Teak leaf extract could offer possible protection to our eyes and sensitize sensors that can be critically affected by accidental exposure to rays from cutting-edge lasers—used everywhere from medical equipment to military devices.

In an era of rapid development of laser technology, there is a need to protect delicate optical devices and human eyes from high-power laser radiation in medical, military and industrial settings.

Scientists at the Raman Research Institute (RRI), an autonomous institute funded by the Department of Science and Technology (DST), Government of India, have uncovered an exciting use for the otherwise discarded leaves of the teak tree (Tectona grandis L.f). While these leaves are usually agricultural waste, they are rich in anthocyanins, natural pigments that give them a reddish-brown hue.

The scientists have spotted an extraordinary power called nonlinear optical (NLO) properties in these pigments when they interact with light. This property of the dye makes the teak leaf a suitable candidate for optical power-limiting applications. This discovery, published in the Journal of Photochemistry and Photobiology A: Chemistry, avoids the use of synthetic optical materials, which are costly and damaging to the environment.

"Teak leaves are a rich source of natural pigments, such as anthocyanin, which imparts a characteristic reddish-brown color when extracted using suitable solvents. Recognizing this, we aimed to explore the potential of teak leaf extract as a non-toxic, biodegradable, eco-friendly and economically viable alternative to synthetic dyes in the field of nonlinear optics. By utilizing this underexploited natural resource, we not only contributed to value-added waste utilization but also promoted the development of sustainable photonic materials with properties comparable to conventional synthetic counterparts," said Beryl C, DST Women Scientist at the Light and Matter Physics theme at RRI.

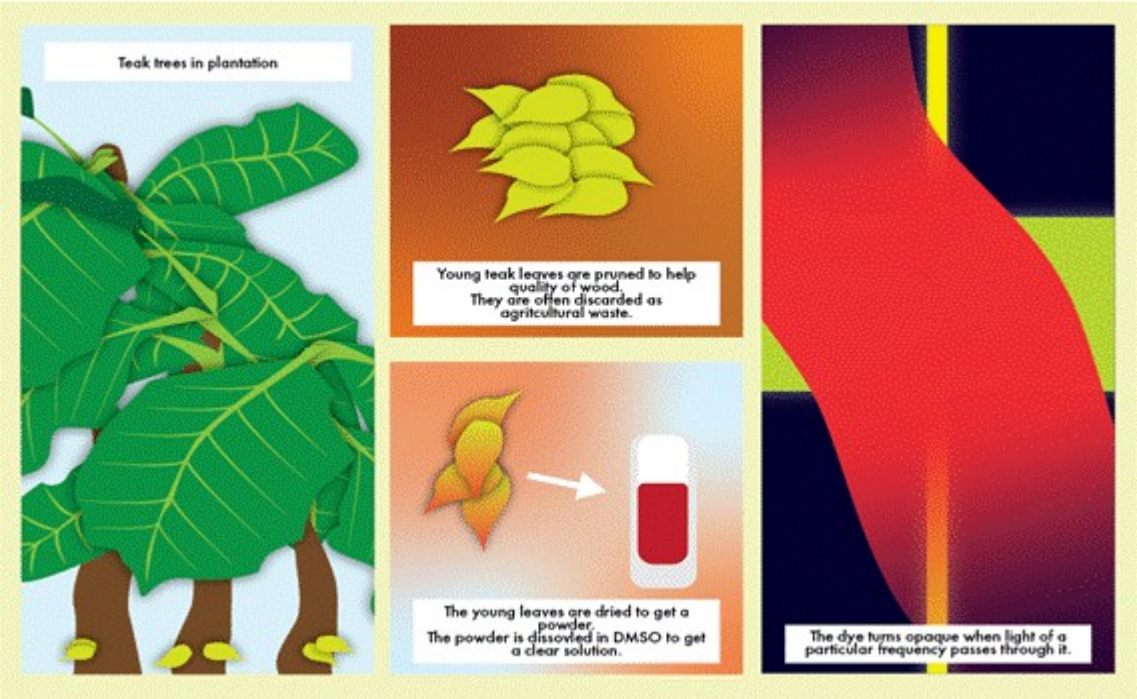

Fig 1: *The process through which Teak Leaf extract is prepared to study the nonlinear optical properties.*

To harness the optical potential of teak leaves, the RRI team dried and powdered the leaves, soaked the powder in solvents, and purified the extract through ultrasonication and centrifugation. They were able to extract a vibrant, reddish-brown liquid dye and shot green laser light through it at two levels of power: one steady (continuous wave), the other pulsing. The dye absorbed the light and adapted to it.

Through sophisticated experiments like Z-Scan and Spatial Self-Phase Modulation (SSPM), they found that the dye showed reverse saturable absorption (RSA). This means the more intense the light, the more the dye absorbed—exactly the behaviour needed for laser safety gear.

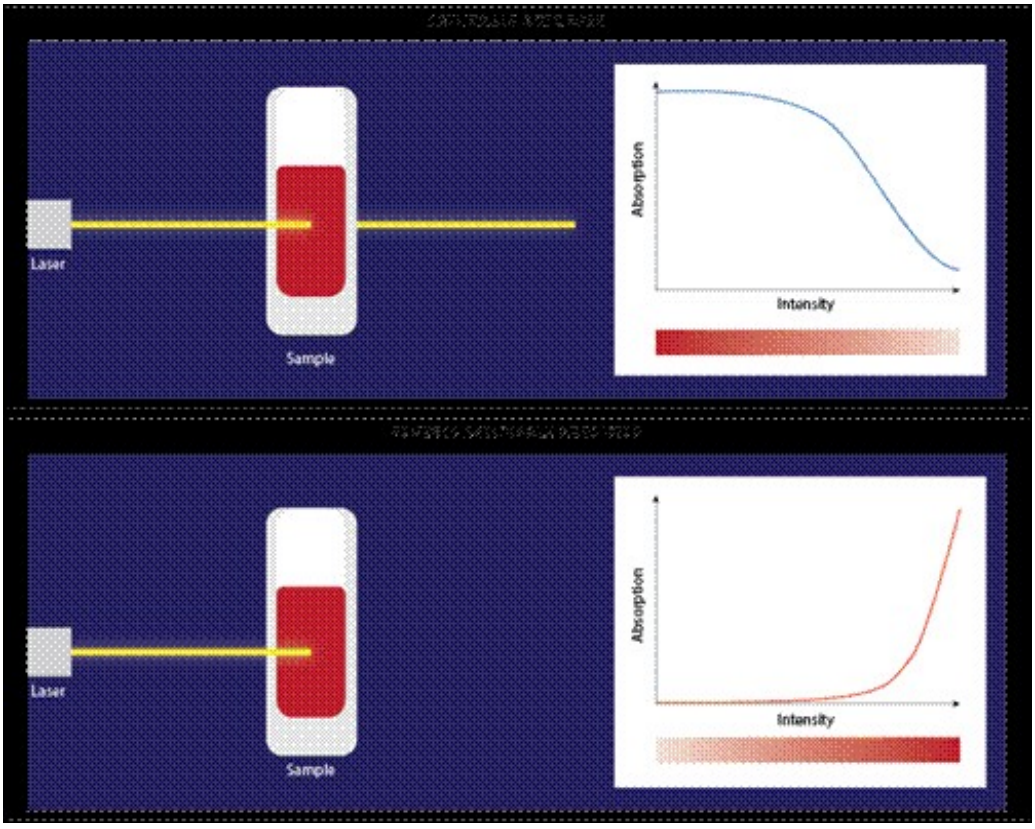

Fig:2 *Saturable Absorbers (SA) vs Reverse Saturable Absorbers (RSA)*

The discovery of natural, eco-friendly optical materials which are inexpensive, compostable and biodegradable is of very high importance regarding the future demands of photonic technologies. Traditional optical limiters rely on expensive materials such as graphene, fullerenes, and metal

nanoparticles, which can be harmful to the environment due to their sophisticated methods of synthesis. In comparison, teak leaf dye is simple to obtain from nature and therefore provides a sustainable solution.

This research opens up new possibilities for the manufacture of modern, eco-friendly laser protective equipment, such as safety goggles, shields for optical sensors, and laser-resistant coatings, making use of the natural teak leaf extract. Future studies could focus on ways to make the dye more stable for long-term use and utilize it in commercial photonic devices. With continued advancements, this natural dye may be used extensively in green optical technologies to reduce the risk of laser-induced damage, making the technological world a less dangerous and more environment-friendly place.

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