Optical Limiter Based on Ferrofluids

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The research team demonstrated optical limiting in a ferrofluid, which has a very high shelf life and remarkable thermal stability, which are said to be the key requirements for sustainable use with intense lasers.

The colloidal suspension contains nanosized particles of approximately 80 Å diameter, with a number density of the order of $10^{22}/m^3$. The nonlinear optical transmission of the samples was studied using nanosecond and femtosecond laser pulses.

The excited state absorption phenomena contribute to the enhanced limiting in the nanosecond excitation regime. An advantageous feature of the ferrofluids in terms of the device applications is that their optical properties can be controlled by an external magnetic field.

Ferrofluids are stable, colloidal suspensions of nanomagnetic materials, typically, magnetite or cobalt, suspended in a suitable base fluid. Magnetite ferrofluids – said to be the oldest variety of ferrofluids – are used owing to their very high saturation magnetization, good thermal stability, and stability against aggolomeration. These smart fluids have been extensively used in several engineering applications, for instance, loudspeaker coils and pressure sensors.

An ideal optical limiter should be transparent to the low energy light pulses and opaque at high energies so that it can protect the human eyes and optical sensors from intense laser radiation.

According to the study, the optical limiting studies had not been reported for ferrofluids till this was undertaken. It is the physical and chemical stability of the ferrofluids, which prompted the research team to investigate their optical limiting properties.

The research team has shown experimentally that the ferrofluids are

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potential candidates for optical power limiting. The good thermal stability, resistance against agglomeration and long shelf life make them attractive for this particular application.

A specific advantage of the ferrofluids is that the optical properties in these materials are tunable by an applied magnetic field. For instance, upon the application of the magnetic field, the linear transmission along the X-Y plane could be changed by a large extent because of the formation of the periodic chain-like structures.

In a typical device application, such magnetocontrollability can turn out to be very useful.

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