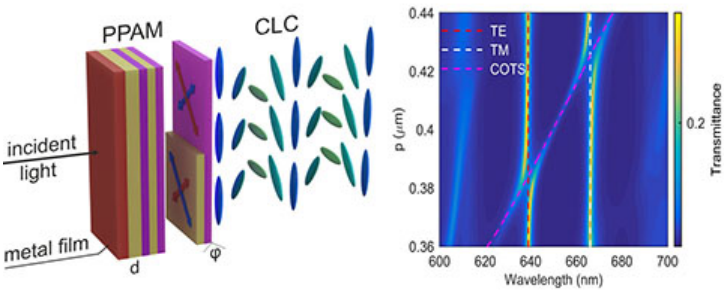
SibFU researchers propose a model of a new easy-to-operate optical device

Researchers from Siberian Federal University and the Institute of Physics of the Krasnoyarsk Research Centre, SB RAS, have proposed the concept of an easily controllable optical device based on hybrid Tamm modes. The research results were published in Applied Optics.



The Tamm mode is a special state of light that occurs when light is localized (blocked) at the border of two highly reflective media. Various materials, such as a multilayer dielectric mirror, a metal mirror, or a chiral liquid crystal mirror, can be used as such media. Spectrally, such modes appear in the spectrum of reflection or transmission of the sample as narrow peaks at the wavelengths at which the light should have been reflected from each medium. If there are more than two boundaries in one system, then several Tamm modes can be simultaneously excited and, accordingly, several peaks appear in the spectrum. By influencing the sample, we can change the parameters of its individual elements, for instance, the spectral region of reflection of a chiral mirror. We can even pick specific parameters so that the spectral peaks coincide with each other. In this case, they are called hybrid Tamm modes. This situation can lead to different types of spectra — in some cases, the peaks can split.

The authors proposed a design of a tunable liquid crystal device based on hybrid Tamm modes. Two different types of Tamm modes are excited in the structure: Tamm plasmons and a chiral optical Tamm state. The former are localized at the interface between a metal film and an anisotropic mirror, and the latter are localized at the interface between an anisotropic mirror and a cholesteric liquid crystal. Tamm plasmons are excited at two different wavelengths for orthogonal linear polarizations, but the chiral Tamm state is excited at only one wavelength, regardless of the polarization of the incident radiation.

One of the potential applications of the proposed device is a tunable laser that can operate in two or three modes.

"*The study of Tamm modes is a very promising area of modern photonics, the interest in which is associated with their applications for various devices, such as lasers, emitters, absorbers, sensors, and devices of photovoltaics and topological photonics. Liquid crystals are a promising element for rearranging the position of Tamm modes. Moreover, they can be not only a service element that changes the optical properties but also works as the reflector. As a rule, cholesteric liquid crystals, which have unusual polarization properties, are used in this capacity. The advantage of the proposed device is the ability to change the spectral position of Tamm modes using external influences, for example, an electric field or a change in temperature, and as a consequence of the value of the splitting of modes*," said **Maxim Pyatnov**, Candidate of Physical and Mathematical Sciences, researcher of the Laboratory of Nanotechnology, Spectroscopy and Quantum Chemistry of the Specialised Department of Photonics and Laser Technology of Siberian Federal University.

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