Microrods made of lanthanoid organic frameworks act as microscale optical waveguides

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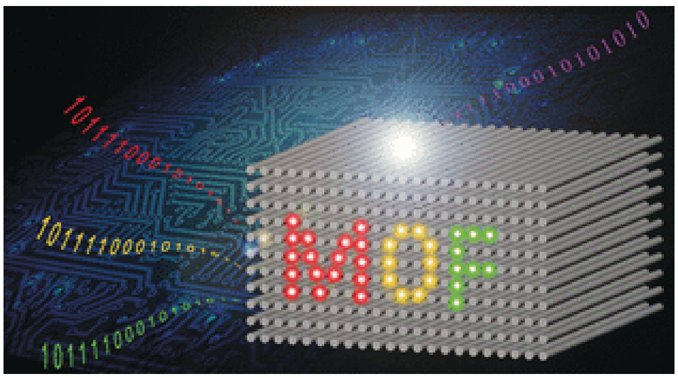

Credit: Wiley

Optical data transmission allows information to be transmitted as light by way of optical waveguides in fiber optic networks. Chinese researchers have now developed microscale optical waveguides. As reported in the journal *Angewandte Chemie*, they have made microrods of lanthanide metal–organic frameworks. Their particular crystal structure ensures low-loss light conduction and the emission of polarized light.

Lanthanides are a group of metals whose special electronic structure makes them attractive for use in optoelectronic applications. Metal–organic frameworks (MOFs) based on lanthanides (Ln-MOFs) offer a wide range of possibilities for targeted variations in structure.

MOFs are lattice-like structures made of metallic "nodes" bridged by organic connectors.

Well-defined, microscale Ln-MOFs have remained a rarity, however. Now, things have changed with the new micro-rod Ln-MOFs, which have potential as microscale waveguides. Led by Dongpeng Yan and Yong Shen Zhao at Beijing Normal University and the Chinese Academy of Sciences (Beijing, China), the researchers chose to use benzenetricarboxylic acid (BTC) as their organic building block. This compound strongly absorbs UV light and has electronic energy levels well matched with lanthanides. In a self-organization process under certain synthetic conditions, the BTC molecules and lanthanide ions assemble into crystalline microrods.

Within the crystal, the BTC molecules function as tiny "light antennas": they capture light and very efficiently pass it on to the lanthanide ions in a radiationless energy-transfer process. The lanthanide ions then emit the energy as luminescence whose color varies depending on the lanthanide used. Terbium MOFs emit green light; europium MOFs glow red. Doping terbium MOFs with 5% europium results in orange luminescence.

Viewed under a microscope, rods evenly irradiated with UV light have very bright points at both ends while only weakly glowing otherwise. The spectrum of the emitted light is constant along the length of the rods. The microrods are thus acting as low-loss optical waveguides. It is also interesting that the light emitted at the ends is circularly polarized and evenly distributed over the cross-section of the rods.

This behavior results from the special crystal structure of the microrods, in which the lanthanide ions wind in a helical chain along an axis of the crystal. The chains are bound together by phenyl groups of the BTC, which form impenetrable walls for the light. The overall result is a threedimensional lattice penetrated by square channels.

With their low light loss and high photoluminescence quantum yield, these novel one-dimensional microstructures could serve as an effective platform for the development of new systems of color tunable optical waveguides with polarized emissions.

More information: Xiaogang Yang et al, Lanthanide Metal-Organic Framework Microrods: Colored Optical Waveguides and Chiral Polarized Emission, *Angewandte Chemie International Edition* (2017). DOI: 10.1002/anie.201703917

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