

PRESS RELEASE

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Why Deep-Sea Dragonfish Have Transparent Teeth

Off the coast of San Diego, 500 meters under the sea, pencil-sized sea monsters grin pitch-black, their mouths filled with transparent teeth. An investigation into this unique adaptation of deep-sea dragonfish (*Aristostomias scintillans*) revealed that their teeth have evolved to reduce light scattering; this makes the fish's wide-open mouth effectively disappear from sight before its jaws snap onto its prey. INM researchers, in collaboration with oceanographers and materials scientists from America, have investigated how and why these teeth are transparent. Under the leadership of Marc Meyers of the University of California, they describe the properties of teeth in a recent publication in the journal *Matter*.

Meyers has teamed up with the Leibniz Institute for New Materials (INM) for uncovering the materials science behind this phenomenon. Marcus Koch, head of Physical Analytics at INM, and Birgit Nothdurft prepared the samples with great effort and analyzed them with a special electron microscope.

They discovered that the transparency of the teeth differs from that developed by other organisms. First, they saw that dragonfish teeth - like human teeth - consist of an outer enamel and an inner dentin layer. However, only nanocrystals about 20 nanometers in size are distributed in an amorphous organic mass of the "tooth enamel". In contrast to human teeth, the tooth lacks dentin tubules that transmit pressure signals or pain sensations in humans. Due to this undisturbed nanostructure, light can pass through the tooth almost unhindered: Light in the environment is not reflected or scattered by the surface of the teeth, making them practically invisible to prey animals. The teeth are also relatively thin compared to other predatory fish, which contributes to this effect.

"Most deep-sea animals have adapted to their environment in a special way. However, the fact that dragonfish have transparent teeth confused us, as this feature is usually found in larger species," says Meyers. "It is fantastic how these animals use a classic principle of light scattering to become invisible to prey. If these teeth were visible, the prey would escape immediately," adds Eduard Arzt of the INM in Saarbrücken. Perhaps this is why the dragonfish is an effective predator despite its small size.

Although they are about 15 centimeters long, deep-sea dragonfish are successful predators in their part of the ocean and feed on smaller fish up to

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50 percent of their size. The most striking feature of the dragonfish is its exceptionally large head full of catch-like teeth. The fish has a dark, eel-like body. The fish are so insatiable they tend to eat each other.

Inspired by this natural model, the researchers aim to design transparent, high-strength materials inspired by dragon teeth, using a combination of nanocrystals and ceramics.

Original publication:

Audrey Velasco Hogan, Dimitri D. Deheyn, Marcus Koch, Birgit Nothdurft, Eduard Arzt, Marc. A Meyers, "On the Nature of the Transparent Teeth of the Deep-Sea Dragonfish, *Aristostomias scintillans*", Matter, DOI: doi.org/10.1016/j.matt.2019.05.010

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