The origin of the color of pearls in iridescence from nano-composite structures of the nacre

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ABSTRACT

The origin of the variety of body colors exhibited by South Sea Pearls is in part due to a newly recognized structure of the nacre, the edge-band structure, which gives rise to interference colors characteristic of its width. With the pearl oyster, Pinctada maxima, the colors include a range of silver tones, creams, yellows, and gold in various degrees of color saturation. We establish here that the primary body color of P. maxima pearls arises from the interference of light within the binding regions of the aragonite tiles. The tile faces terminate in a fissured nano-composite structure containing organic matrix within the margin of the aragonite tiles. This edge-band structure gives rise to an optical film formed of organic matrix in aragonite. The TEM images show that the edge-band structure width increases progressively from 74(4) nm in a silver pearl, to 80(4) nm in a cream pearl, and to 90(4) nm in a gold pearl. These colors are the first-order Newton’s colors, which, when mixed with the specular reflection of the nacre and modified by any pigmentation present, give rise to the body color of pearls. The non-metallic whiter pearls more commonly seen can be accounted for by disorder of this structure leading to unsaturation of the color.