Experimental and Numerical Investigation of Relation between Color and Thickness of Extremely Thin Soap-Bubble Films

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The color of soap-bubble films changes with thickness due to light interference. As a film become thinner with time, it would normally be expected to become blue or violet as the wavelength decreases. However, we found that after initially being red and green, films become gold, white, and colorless. In order to clarify the reason for this, we measured and simulated the reflection spectra of soap bubbles. First, to obtain reflection spectra with a good S/N ratio, we constructed an apparatus that could measure the reflected light intensity distribution (LID). We found that the spectrum of gold-colored films occupied the entire visible light region. Next, we compared the experimental and theoretical reflected LID, and found that the peak wavelengths and intensities were in agreement. This indicates that the gold color is the result of light interference. This evaluation method can also determine the film thickness down to approximately 50 nm. We therefore measured the temporal change in the film thickness until the film broke. We found that the reduction in film thickness was discontinuous, and films with thicknesses between 70 and 110 nm did not exist. Films with thicknesses in this range would be expected to appear blue and violet. Consequently, we concluded that soap-bubble films do not appear blue or violet because the corresponding film thicknesses do not exist. Also, films appear gold before becoming colorless because of their strong red and green components.