High-Pressure Raman Spectroscopy and Optical Properties of $Cs_2NaInCl_6$:X (X = Cr, Mo)

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Raman spectroscopy is a powerful method for studying vibrations in solids, molecules, and crystals. It provides direct information about lattice dynamics, local structure, chemical bonding, and structural changes under external conditions. In high-pressure experiments, Raman spectra are especially useful because they can reveal phonon shifts, symmetry changes, and possible phase transitions. For this reason, Raman spectroscopy is an important tool for understanding how materials respond to compression and for linking structural changes with optical properties.

In recent years, perovskite materials have attracted great attention because of their interesting structural and optical properties. Among them, halide double perovskites are especially promising because they can offer better chemical stability and lower toxicity than many lead-based perovskites. These materials are also attractive host lattices for luminescent ions, including transition metals, which can strongly modify their emission properties. As a result, double perovskites are now considered an important group of materials for optical and spectroscopic applications.

In this work, we mainly focus on the basic luminescence properties of $Cs_2NaInCl_6$:X (X = Cr, Mo), especially its emission and excitation spectra. The studied materials show broadband near-infrared emission with a maximum in the 950–1000 nm range, which is related to the presence of Cr^{3+} or Mo dopant ions in the double perovskite host. We then investigate the high-pressure Raman spectra in order to understand how lattice vibrations change under compression and how these changes are related to the optical response of the material.

In addition, we show that 3D printing is a useful tool for high-pressure research. It allows fast and low-cost fabrication of custom parts for the pressure setup, improves repeatability, and simplifies experimental preparation.

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