

Phonon Interaction and Phase Transition in Single Formamidinium Lead Bromide Quantum Dots

- Supporting Information -

*Oliver Pfingsten¹, Julian Klein¹, Loredana Protesescu^{2,3}, Maryna I. Bodnarchuk², Maksym V.
Kovalenko^{2,3} and Gerd Bacher¹*

1. Werkstoffe der Elektrotechnik and CENIDE, Universität Duisburg-Essen, Bismarckstraße 81,
47057 Duisburg, Germany.

2. Laboratory for Thin Films and Photovoltaics, Empa – Swiss Federal Laboratories for
Materials Science and Technology, Überlandstrasse 129, CH-8600 Dübendorf, Switzerland

3. Institute of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH
Zürich, Vladimir Prelog Weg 1, CH-8093 Zürich, Switzerland.

Table of content

Figure S1. PL spectra of FAPbBr₃ QDs embedded in PMMA with different QD concentrations and measured at a temperature of 4 K with an excitation power density of 130 W/cm².

Figure S2. Intensity of the ZPL and the first order phonon replica E₁ versus excitation power density. The dashed lines have a slope of 1.

Figure S3. a) Energetic distance of the second phonon replica E₂ to the ZPL versus distance of the first replica E₁ to the ZPL. b) Intensity ratios $I(E_2) / I(E_3)$ versus $I(E_1) / I(E_2)$.

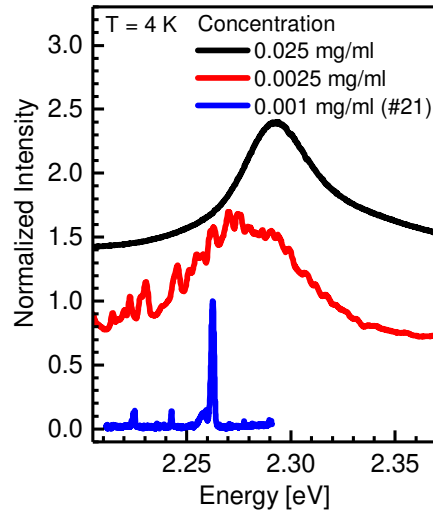


Figure S1. PL spectra of FAPbBr₃ QDs embedded in PMMA with different QD concentrations and measured at a temperature of 4 K with an excitation power density of 130 W/cm². The emission changes from a continuous spectrum at 0.025 mg/ml over multiple peaks at 0.0025 mg/ml down to emission from an individual QD at 0.001 mg/ml. For the QD labeled #21, the peaks at around 2.225 eV and 2.242 eV are related to phonon replica of the zero phonon emission at 2.263 eV (see discussion in the main text).

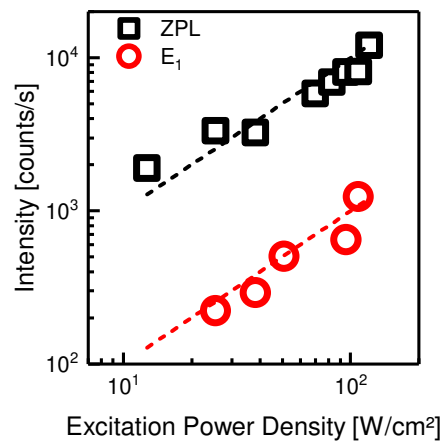


Figure S2. Intensity of the ZPL and the first order phonon replica E₁ for a selected QD (labelled #25) versus excitation power density. The dashed lines have a slope of 1.

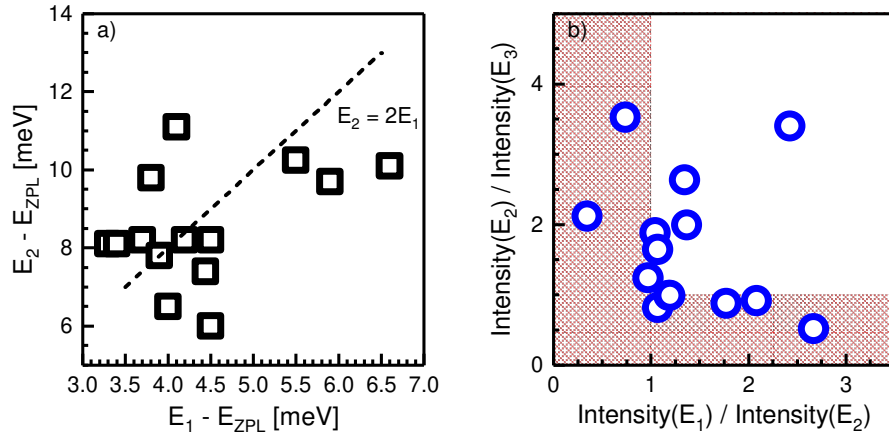


Figure S3. a) Energetic distance of the second phonon replica E_2 to the ZPL versus distance of the first replica E_1 to the ZPL. Each symbol represents a different single quantum dot. The dashed line indicates $E_2 = 2E_1$, demonstrating that two different phonons are involved. b) Intensity ratios $I(E_2) / I(E_3)$ versus $I(E_1) / I(E_2)$. According to the Huang-Rhys characteristics, no data points are expected in the red marked areas in case the three different replicas are first or higher order contributions of the same phonon. The data indicate that 3 different phonons are responsible for the replica.