Advancements in Organic-Inorganic Hybrid (OIH): From Synthesis to Applications in Electronics

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Over the past few decades, the development of organic-inorganic hybrid (OIH) compounds has garnered considerable interest for their diverse applications and unique properties stemming from the mixture of organic and inorganic precursors. OIH materials can be easily produced by the sol-gel method under moderate synthesis conditions [1], enabling tailored properties such as optical, electrical, and mechanical attributes through the integration of organic polymers with inorganic materials in a single phase. Subjected to external stimuli, these materials exhibit switchable properties [2], making them suitable for applications like electrical signal modulation, sensors, and memory devices. Notably, hybrid organic-inorganic perovskites (HOIPs) have achieved power conversion efficiencies exceeding 24% in a decade of research, showcasing their remarkable photovoltaic properties [3].

This research focuses on studying the physical properties of OIH compounds obtained using the slow isothermal evaporation method. Highly pure single-phase organic-inorganic quinuclidine-based Figure 1 (a) crystals were successfully synthesized. Comprehensive investigations into physical properties using differential scanning calorimetry (DSC) and Broadband Dielectric Spectroscopy (BDS) have been conducted. Through thermal analysis, we demonstrated phase transitions Figure 1 (b) and changes in specific entropy, with DSC measurements revealing the presence of reversible phase transitions in all synthesized compounds Figure 1 (c).

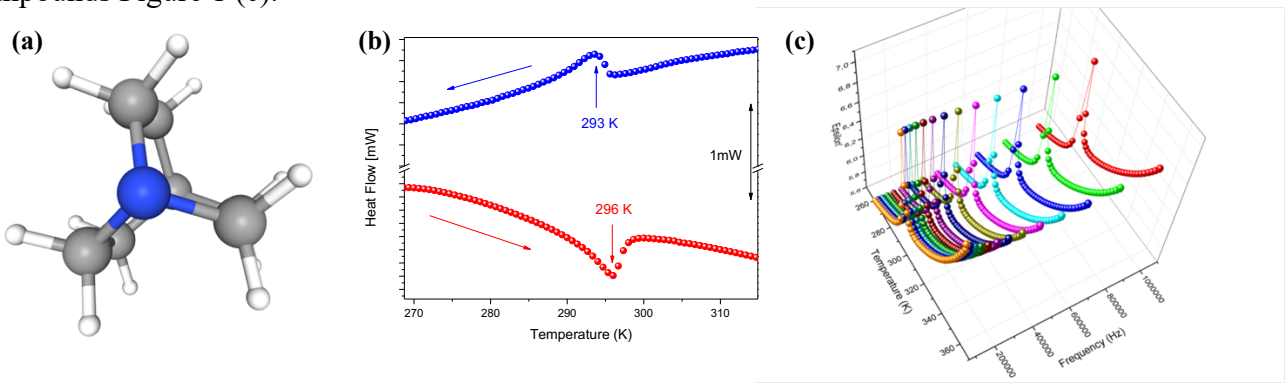

Figure 1: (a) Quinuclidine molecule with hydrogen atoms attached. (b) The temperature dependence of the heat flow during the cooling/heating cycle for quinuclidine-based crystals. (c) The temperature-dependent real part (ε′) of dielectric permittivity for selected frequencies.

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[2] E. Jach, D. A. Kowalska, M. Gusowski, M. Trzebiatowska, M. Krupinski, W. Medycki, J. Jędryka,P. Staniorowski and A. Cizman, The Journal of Physical Chemistry C 2023 127 (5), 2589-2602

[3] D. A. Egger, A. M. Rappe & L. Kronik, "Hybrid Organic–Inorganic Perovskites on the Move," "Accounts of Chemical Research," 2016, vol. 49, no. 3, pp. 573–581.