Mn^{5+}-activated Phosphors: Potential and Limits for Temperature and Pressure Sensing

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While Mn^{5+}-activated materials have a long history in pigments and NIR lasers [1,2], their unique $3d^2$ electronic configuration continues to offer untapped potential for modern optical challenges. This talk examines the transition of Mn^{5+} research from its foundational spectroscopic roots in the 1960s [3] to its current status as a multifunctional dopant with potential in the next-generation NIR-II contrast agents [4], NIR LED lighting [5], and particularly in optical sensing [6-8]. The correlation between the structural preference of Mn^{5+} for tetrahedral sites and the resulting sharp $^1E \rightarrow {}^3A_2$ emission that defines its performance will be discussed in the context of the Tanabe-Sugano theory. Special emphasis will be placed on the correlation between the parameters describing the luminescent ion local site and optical performance of Mn^{5+}-activated phosphors for temperature and pressure sensing. Moreover, considering phosphates and vanadates as example, the PL emission modulation through the crystal field control is presented. Finally, general trends, possibility of predictions and limitations will be discussed.

[1] W. Klemm (1954) Angew. Chem., 66, 468.
[2] L. D. Merkle, A. Pinto et al. (1992) Appl. Phys. Lett., 61, 2386.
[3] J. D. Kingsley, J. S. Prener, B. Segall (1965) Phys. Rev., 137, A189.
[4] P. M. Gschwend, K. Keevend et al. (2021) J. Mater. Chem. B, 9, 3038.
[5] V. Rajendran, K.-C. Chen et al. (2023) ACS Energy Lett., 8, 289.
[6] P. M. Gschwend, D. Niedbalka et al. (2020) Adv. Sci., 7, 2000370.
[7] M. D. Dramicanin, L. Marciniak et al. (2022) Light Sci. Appl., 11, 279.
[8] M. Back, J. Cangiotti et al. (2026) Adv. Optical Mater., 14, e03109.

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