Development of mechanoluminescence and multipiezo materials

Xu C.N.

Department of Materials Science and Engineering, Tohoku University, Japan;
*chao-nan.xu.c8@tohoku.ac.jp

The emergence of novel mechanoluminescent (ML) materials, such as $SrAl_2O_4$ and ZnS, which can emit light repeatedly under even a gentle touch, has generated significant research interest in developing materials, devices, and systems for various applications[1,6]. This talk outlines the crystal structures, underlying mechanisms, and ML behaviors of key material systems, including $SrAl_2O_4$-, ZnS-, $LiNbO_3$-, and $Sr_3Sn_2O_7$-based ferroelectric compounds. These multipiezo materials simultaneously exhibit intrinsic piezoluminescence—ML triggered purely by elastic deformation without frictional effects—and piezoelectricity, enabling unique synergies between mechanical force, electric fields, and light for applications such as stress sensing.

Recent investigations have underscored the importance of crystal structure, doping strategies, and piezoelectric properties in enhancing ML efficiency and reliability. The promising characteristics of ML materials suggest their potential use in stress and force sensors, structural health monitoring, mechanically responsive lighting, and advanced imaging technologies. Continued exploration and refinement of multipiezo materials may lead to groundbreaking advancements, further broadening their applicability in industrial and scientific fields. The study of ferroelectric ML materials also paves the way for the development of next-generation materials with distinctive electro-mechano-optical conversion properties.

References

1. Xu. C. N., et.al., Appl. Phys. Lett., **1999**, 74(9), 1236-1238.
2. Xu. C. N., et.al., Appl. Phys. Lett., **1999,** 74(17), 2414-2416.
3. Tu D., Xu C. N., et.al., Adv. Mater., **2017**, 29(22), 1606914.
4. Uchiyama, T.; Zheng, X.G.; Xu, C.N. *APL Mater.*, **2024**, 12, 090901.
5. Kawana,S., Hirata, K., Fujio Y.,Uchiyama, T.,Xu, C.N. *Adv. Theory Simul.,* **2024**, 7, 2400099.
6. Zheng X.G., Xu C. N., Uchiyama T., et al., *Adv. Sci.*, **2024**, 12, 2410977.