

# **Electrocaloric Relaxor Ferroelectric Polymer Materials for Dielectric Refrigeration: Novel Developments and Future Perspectives**

Zdravko Kutnjak<sup>C, S</sup> and Brigita Rozic  
*Condensed Matter, Jozef Stefan Institute, Ljubljana, Slovenia*  
*zdravko.kutnjak@ijs.si*

Qiming Zhang  
*Materials Research Institute, The Pennsylvania State University, University Park, PA, U.S.A.*

The electrocaloric effect (ECE) has been known for many decades, however, the relatively small ECE observed (less than 2.5 K), made it unsuitable for practical applications. Recently, however, materials with large ECE have been predicted and discovered thus opening the possibility of realizing dielectric refrigeration that has several potential advantages in comparison to other cooling technologies [1,2], including better energy efficiency. The recent findings of large ECEs in relaxor ferroelectric polymers have attracted great interest for developing new cooling technology that is more environmentally friendly than the existing cooling technologies [3,4]. A review of recent ECE findings obtained in polymeric ferroelectric and relaxor materials will be given. Besides the materials progress, recent advances in development of practical cooling devices utilizing different approaches and materials will be presented [5].

## References

- [1] A. S. Mischenko et al., *Science* 311, 1270 (2006).
- [2] B. Neese et al., *Science* 321, 821 (2008).
- [3] R. Pirc, Z. Kutnjak, R. Blinc, Q.M. Zhang, *Appl. Phys. Lett.* 98, 021909 (2011).
- [4] S.-G. Lu, B. Rozic, Q. M. Zhang, Z. Kutnjak, R. Pirc, *Appl. Physics. A*, 107, 559 (2013).
- [5] H. Gu et al., *Appl. Phys. Lett.* 102, 122904 (2013).