Lead Scandium Tantalate: From B-Sites through Thermal Sights to Cool Nights

R.W. Whatmore[1*], S. Crossley[2], B. Nair[2], X. Moya[2], N.D. Mathur[2], G.T. Andrews[3], S. Spencer[3], M.J. Clouter[3] and R. Beanland[4]

[1]Department of Materials, Imperial College London, London, SW7 2AZ, United Kingdom
[2]Materials Science, University of Cambridge, Cambridge, CB3 0FS, United Kingdom
[3]Dept. of Physics & Physical Oceanography Memorial University St. John's NL Canada A1B3X7
[4]Dept of Physics, University of Warwick, Warwick, CV4 7AL, UK
*Roger W. Whatmore: r.whatmore@imperial.ac.uk

Ferroelectric relaxors were a career-long interest for Dr Eric Cross because they are both useful (in e.g. dielectrics and mechanical actuators) and intellectually challenging to understand – an irresistible combination for him. The complex perovskite lead scandium tantalate – Pb_2ScTaO_6 (PST) –fascinated him because of its ability to change chameleon-like from being an excellent relaxor when the Sc and Ta ions are disordered to a conventional first-order ferroelectric when they are ordered. Some of the earliest publications on this effect came from his work with Nava Setter. In the mid-1980's, Cross visited Plessey Caswell in the UK to spend some time with his great friend Frank Ainger and the ferroelectrics group there, where we were developing pyroelectric thermal imagers. We had an interest with colleagues under Rex Watton at RSRE Malvern in employing ferroelectrics close to T_C with an applied DC electric bias to create an "induced" pyroelectric effect – the so-called "dielectric bolometer" mode of pyroelectric operation. Cross suggested the use of PST, as its T_C is ca 300K, so we hot pressed some ceramic and the results were excellent – it is still the best of the dielectric bolometer materials[1, 2]. A number of infra-red imaging products were developed off the back of this work, with element counts up to 388x284, a world record at the time. Of course, anything with a good pyroelectric effect has the potential for electrocaloric applications (something recognised at about the same time by Andris Sternberg in Riga[3]), and with the explosion of interest in electrocalorics in the last 10 years[4], PST is now being revisited for solid state cooling applications. PST continues to fascinate and this talk will review its history from a structural, pyroelectric and electrocaloric point of view, taking in the latest results on its structural and electrocaloric properties.

1. R. W. Whatmore, A. Patel, N. M. Shorrocks and F. W. Ainger, Ferroelectrics **104**, 269 (1990).
2. J. R. Giniewicz, A. S. Bhalla and L. E. Cross, Ferroelectrics Letters Section **14**, 21 (1992).
3. L. A. Shebanov, E. H. Birks, K. J. Borman and A. R. Sternberg, Ferroelectrics **94** (1), 305 (1989).
4. A. S. Mischenko, Q. Zhang, J. F. Scott, R. W. Whatmore and N. D. Mathur, Science **311**, 1270 (2006).