Magnetic and electrical properties of $CoRE_2W_2O_{10}$ ceramic materials

B. Sawicki[1], E. Tomaszewicz[2], T. Groń[1], M. Oboz[1], I. Gruszka[1], A. Guzik[1], P. Urbanowicz[1]

[1]*Institute of Physics, University of Silesia in Katowice, 40-007 Katowice, Poland*
[2]*Faculty of Chemical Technology and Engineering, Department of Inorganic and Analytical Chemistry, West Pomeranian University of Technology in Szczecin, 71-310 Szczecin, Poland*

Divalent metals tungstates, MWO_4 (M = Mn, Co, Zn, Cd and Pb), have been successfully used in spectroscopic and radiometric devices and as heavy and fast scintillators [1]. Many of them, *i.e.* when ionic radius of M^{2+} is relatively small, adopted monoclinic wolframite-type structure [2]. In turn, trivalent rare-earth metals tungstates (RE_2WO_6) exhibit many structural types including monoclinic symmetry with space group C2/c (where RE = Pr–Dy) [3]. They have been used in diode-pumped crystal lasers, new generation lighting in optical telecommunications, lidars and other applications requiring narrow spectral sources [4]. Our earlier studies on $MPr_2W_2O_{10}$ (M = Mn, Co and Cd) and $CdRE_2W_2O_{10}$ (RE = Y, Nd, Sm, Gd–Er) tungstates obtained by high-temperature sintering of adequate MWO_4/RE_2WO_6 mixtures showed that these new compounds crystallize with orthorhombic or monoclinic structure and exhibit generally non-conductive and paramagnetic properties [5,6].

Samples of other new $CoRE_2W_2O_{10}$ (RE = Y, Dy, Ho, Er) tungstates were obtained by high-temperature solid-state reaction method using $CoWO_4$ and RE_2WO_6 as the starting materials [7]. These materials were pressed and sintered at 1050°C to a ceramic form. Powder diffraction measurements of as-prepared sinters were carried out on a PANalytical PW1050 diffractometer. Static dc magnetic susceptibility was measured within the temperature range of 2–300 K in the zero-field cooled (ZFC) and field cooled (FC) mode. For these purposes a Quantum Design MPMS-XL-7AC SQUID magnetometer (Quantum Design, USA) was used. Electrical conductivity $\sigma(T)$ was measured by the dc method using a KEITHLEY 6517B Electrometer/High Resistance Meter within the temperature range of 77–400 K. Broadband dielectric spectroscopy measurements were carried out using pellets, polished and sputtered with (~80 nm) Ag electrodes within the frequency range of $2\cdot10^2 - 2\cdot10^6$ Hz using a Hioki 3532-50 LCR HiTester and within the temperature range of 80–400 K.

The results of structural, magnetic and electrical measurements of $CoRE_2W_2O_{10}$ ceramics (RE=Y, Dy, Ho, Er) showed orthorhombic-type structure, paramagnetic state and insulating behaviour as well as a large value of relative permittivity above room temperature, which strongly depends on presence of 3*d* Co^{2+} ions, but not on the type of 4*f* RE^{3+} ones. The important property of ceramic samples is that they have a greater ability to accumulate charge in comparison with the micro-crystalline ones.

[1] V.G. Bodnar, S.F. Burachas, K.A. Katrunov, V.P. Martinov, V.D. Ryzhikov, V.I. Manko, H.H. Gutbrod, and G. Tamulaitis, *Nucl. Instrum. Methods Phys. Res. A* **411**, 376 (1998).
[2] A.W. Sleight, *Acta Crystallogr. B* **28**, 2899 (1972).
[3] A.A. Evdokimov, V.A. Efremov, and V.K. Trunov, Compounds of the Rare Earth Elements: Molybdates and Tungstates, Nauka, Moscow, 1991 (in Russian).
[4] G. Boulon, *Opt. Mater.* **34**, 499 (2012).
[5] Z. Kukuła, E. Tomaszewicz, S. Mazur, T. Groń, H. Duda, S. Pawlus, S.M. Kaczmarek, H. Fuks, and T. Mydlarz, *Philos. Mag.* **92**, 4167 (2012).
[6] Z. Kukuła, E. Tomaszewicz, S. Mazur, T. Groń, S. Pawlus, H. Duda, and T. Mydlarz, *J. Phys. Chem. Sol.* **74**, 86 (2013).
[7] E. Tomaszewicz, *J. Therm. Anal. Cal.* **93**, 711 (2008).