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Evolution of Mechanical Stresses in Extruded $(\text{Bi}_{1-x}\text{Sb}_x)_2(\text{Te}_{1-y}\text{Se}_y)_3$ Thermoelectric Alloys subjected to Thermal Shocks present in Module Fabrication Processes

R. Pelletier¹, S. Turenne¹, A. Moreau², D. Vasilevskiy¹, R.A. Masut¹

¹ *Ecole Polytechnique de Montréal, c.p. 6079, succ. CV, Montreal (QC), H3C 3A7, Canada*

² *Industrial Materials Institut, National Research Council of Canada, 75 de Mortagne Blvd., Boucherville (QC), J4B 6Y4, Canada*

Circular cross section rods of high performance $(\text{Bi}_{1-x}\text{Sb}_x)_2(\text{Te}_{1-y}\text{Se}_y)_3$ thermoelectric alloys were produced from pure element pellets by mechanical alloying followed by a hot extrusion process. The fabrication of thermoelectric coolers usually starts by slicing thin (0.5-1.5 mm) disks of extruded alloys which are then submitted to quenching, with a concomitant thermal shock, during the metallization process. We have experimentally determined important material properties such as specific heat, thermal conductivity and coefficient of thermal expansion, in order to evaluate the thermal shock resistance of these materials, using numerical simulations. We have experimentally estimated the heat transfer coefficients obtained while quenching the disks in a bath of soldering alloy, and the anisotropic elastic properties and their spatial variations within the rod were measured by ultrasound techniques. Numerical 2-D and 3-D simulations of the quenching process were used to estimate the evolution of mechanical stresses during the heat exchanges. The stress levels are used to interpret quench test results obtained in water-based solutions and in 95%Sn-5%Sb soldering alloy at different temperatures. The behaviour of textured hot-extruded alloys is discussed and compared to that of commonly used directionally solidified materials.