

Session: Environmental Risks of Energy Generation

Title: Evaluating the read-across approach on CdTe toxicity for CdTe photovoltaics

Cadmium telluride (CdTe) is a semiconductor compound used in CdTe photovoltaic (PV) cells, an important thin film PV technology that is expected to reach nearly 4 GW in annual production capacity by 2014. Because there is limited energy and water use during operation, PV poses few environmental impacts and risks compared with other energy generation methods. The principal environment, health, and safety (EHS) issue for CdTe PV is the potential introduction of cadmium (Cd) compounds into the environment. This has been evaluated on a life cycle basis (Fthenakis, 2004) with regard to raw material, manufacturing, use, and decommissioning stages and found to produce minimal environmental emissions (0.02 g Cd per GWh). In evaluating risk from these emissions, toxicological data is often read-across from the parent element (Cd) to the compound (CdTe), because of limited specific toxicological data on CdTe. However, recent toxicity studies indicate that this may not be appropriate. Zayed and Philippe (2009) evaluated acute inhalation and oral toxicities of CdTe in rats and found the median lethal concentration and dose to be orders of magnitude higher than that of Cd. Prior testing by Harris et al. (1994) showed no detectable effects of CdTe on male or female rat reproduction. Additional research on toxicity and ecotoxicity of CdTe is presented here, based on OECD, ASTM, and US EPA EHS test guidelines. CdTe was tested with bacterial reverse mutation assay (Ames test), and no mutagenic activity was found. This compares to positive mutagenicity results for Cd (Oberly et al., 1982). The bioavailability of CdTe was evaluated with a simulated gastric fluid (pH of 1.5) and yielded 11 mg of cadmium per g of cadmium telluride (~1%). This compares to a read-across value of 100% for cadmium chloride. Transformation and dissolution testing to evaluate aquatic toxicity yielded a concentration of Cd below the LOAEL of 18 ug/L. Acute toxicity was evaluated for Zebrafish over an exposure period of 96 hours at the limit of solubility for CdTe, and there was no toxic effect at aquatic saturation on fish. Overall, CdTe is differentiated from Cd, indicating that simple read-across from CdTe to Cd is not appropriate. Therefore, in addition to minimal life cycle environmental emissions, environmental risks from CdTe PV are minimized by differences in toxicity between CdTe and Cd.