Lead telluride (PbTe) was electrochemically synthesized in NaOH solution at room temperature, and the reduction mechanism of PbTe was investigated using cyclic voltammetry and chronoamperometry. The reduction of Pb(II) to Pb(0) in 5 mM Pb(NO$_3$)$_2$ - 100 mM NaOH solution was a one-step two-electron transfer process, while the reduction of Te(IV) to Te(0) in 10 mM TeO$_2$ - 100 mM NaOH solution was a one-step four-electron transfer process. PbTe deposits were obtained at a potential range from −0.95 V to −1.05 V (vs. Hg/HgO) in a mixture of 10 mM TeO$_2$, 5 mM Pb(NO$_3$)$_2$, and 100 mM NaOH solution. The nucleation mechanisms of Pb and Te were three-dimensional instantaneous and progressive nucleation, respectively. However, the nucleation mechanism of PbTe was a combination of three-dimensional instantaneous and progressive nucleation at −1.0 V (vs. Hg/HgO). The nucleation mechanisms at different potentials correspond to the dominant electrodeposited element.

**Keywords:** PbTe, nucleation, electrodeposition, thermoelectric material, NaOH