

N-type $\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$ 열전 합금에서 Te 공공 형성에 의한 열전 성능 연구

AEML

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Introduction of Thermoelectric

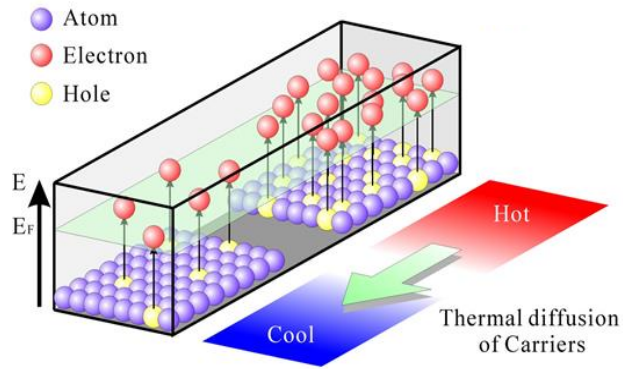


Figure 1. Thermoelectric Principle

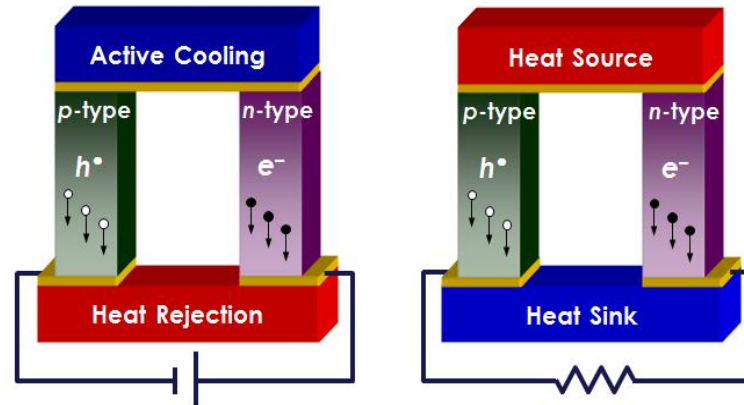


Figure 2. Peltier Effect and Seebeck Effect

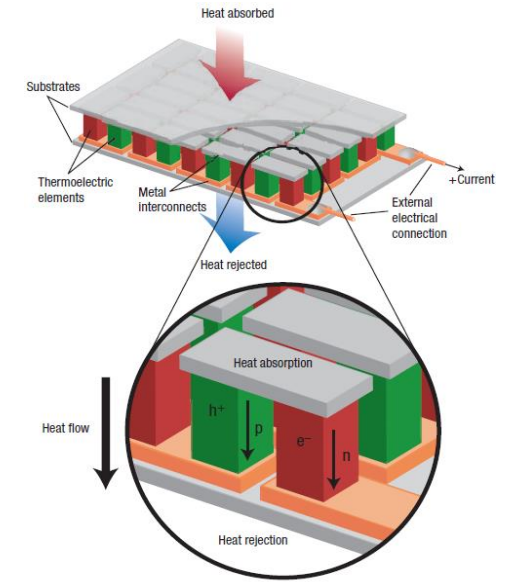


Figure 3. Structure of Thermoelectric module

$$zT = \frac{\sigma S^2}{\kappa} T$$

electrical conductivity σ [S/cm]
 Seebeck coefficient, S [$\mu\text{V}/\text{K}$]
 Thermal Conductivity [$\text{W}/\text{m} \cdot \text{K}$]
 Absolute Temperature, T [K]

$$P.F. = \sigma S^2$$

Power Factor, $P.F.$ [mW/mK^2]

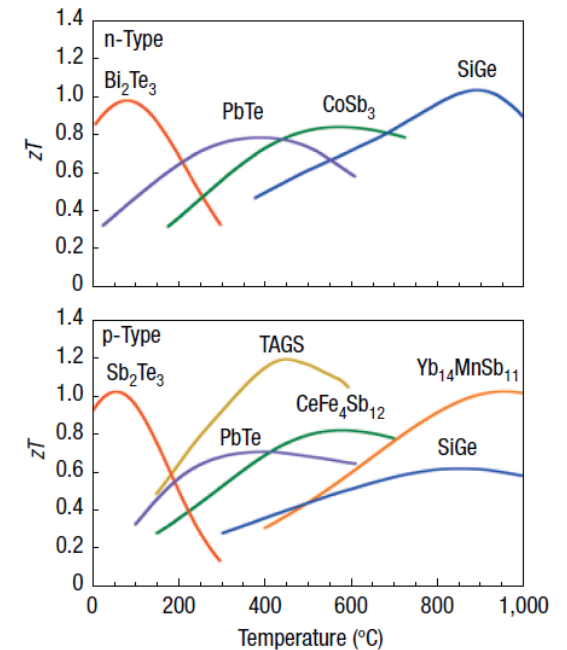


Figure 4. Dimensionless figure of merit zT , according to materials

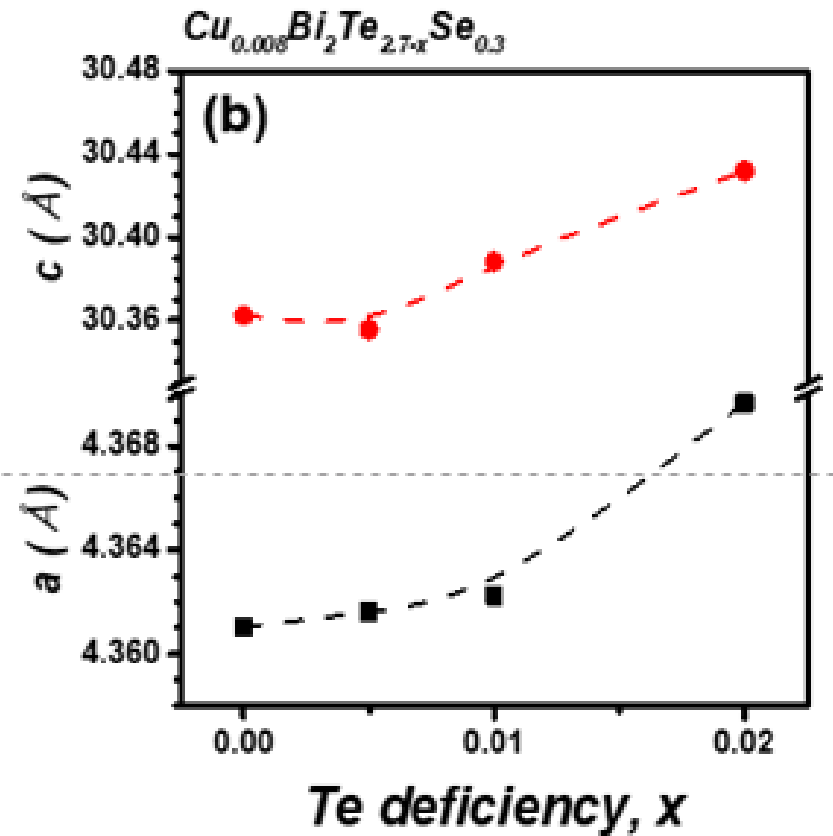
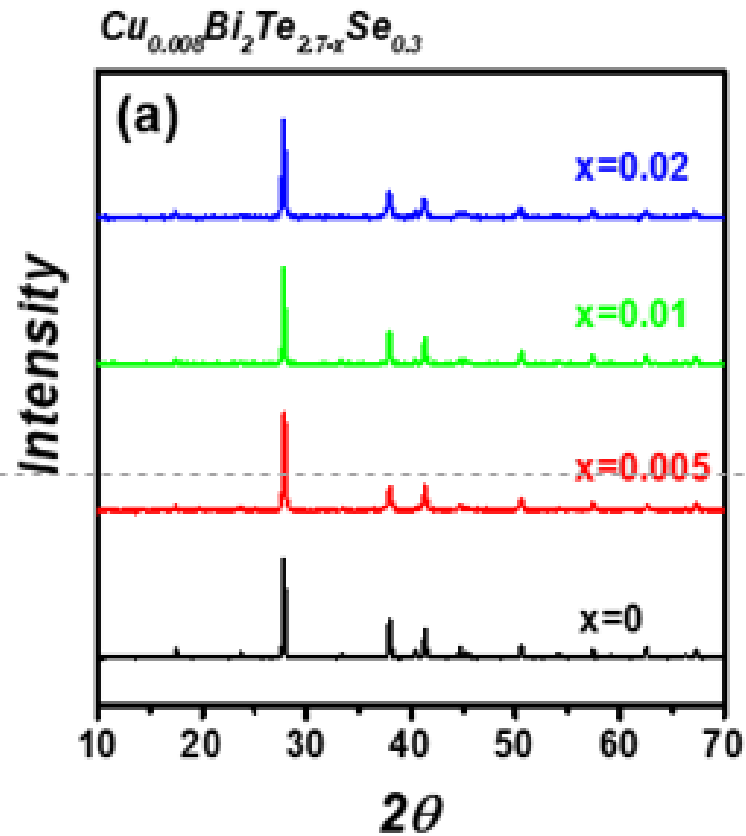


Fig. 5. X-ray diffraction patterns of (a) $\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$ and (b) Calculated lattice parameters a and c of the $\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$ with $x=0, 0.005, 0.01$ and 0.02 .

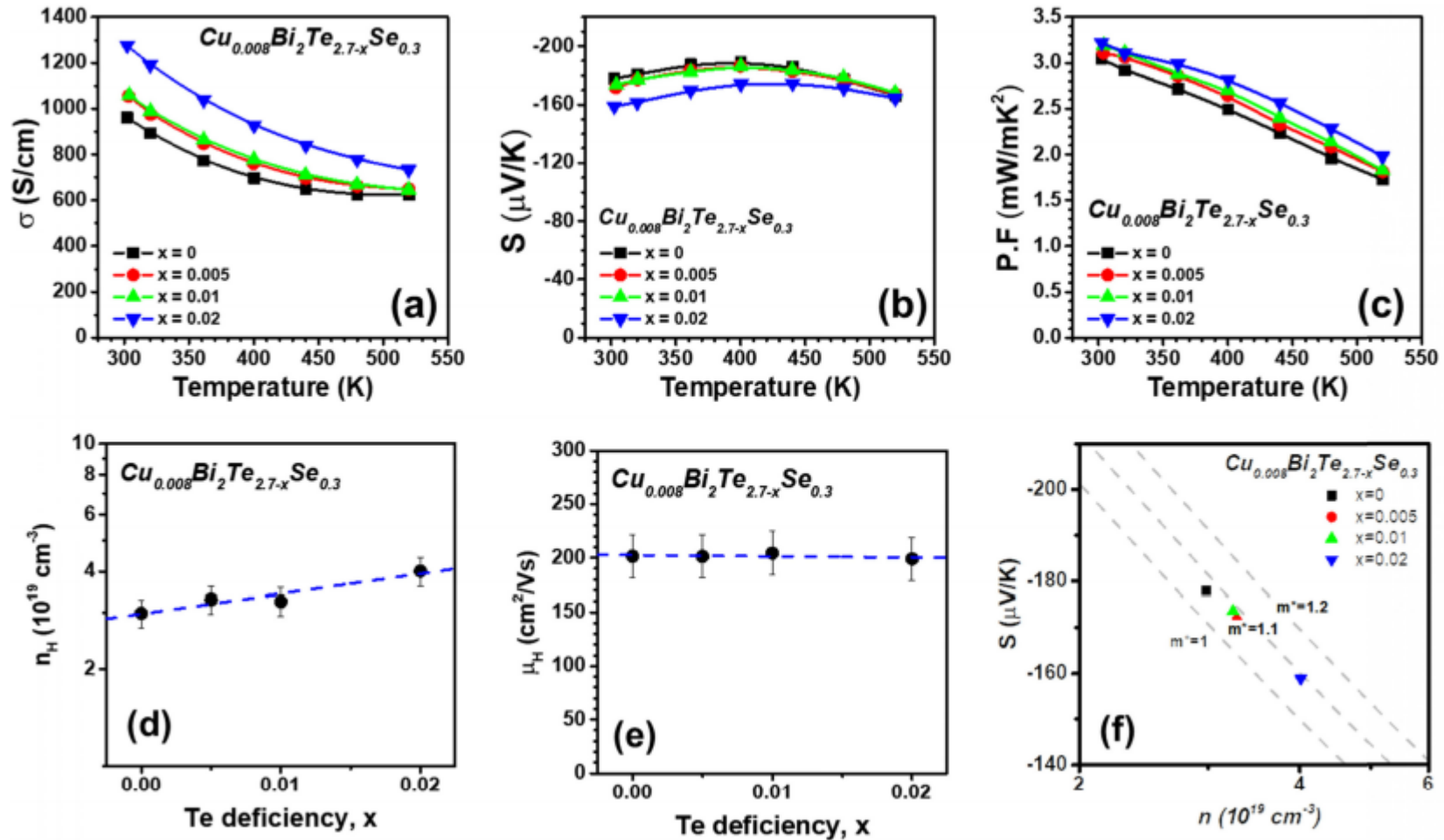


Fig. 6. (a) The measured electrical conductivity σ , (b) Seebeck coefficient S and (c) power factor σS^2 of the samples as a function of temperature for the $\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$ with $x=0, 0.005, 0.01, 0.02$. (d) (e) Estimated carrier concentrations and mobilities from the Hall measurement. (f) Pisarenko plot.

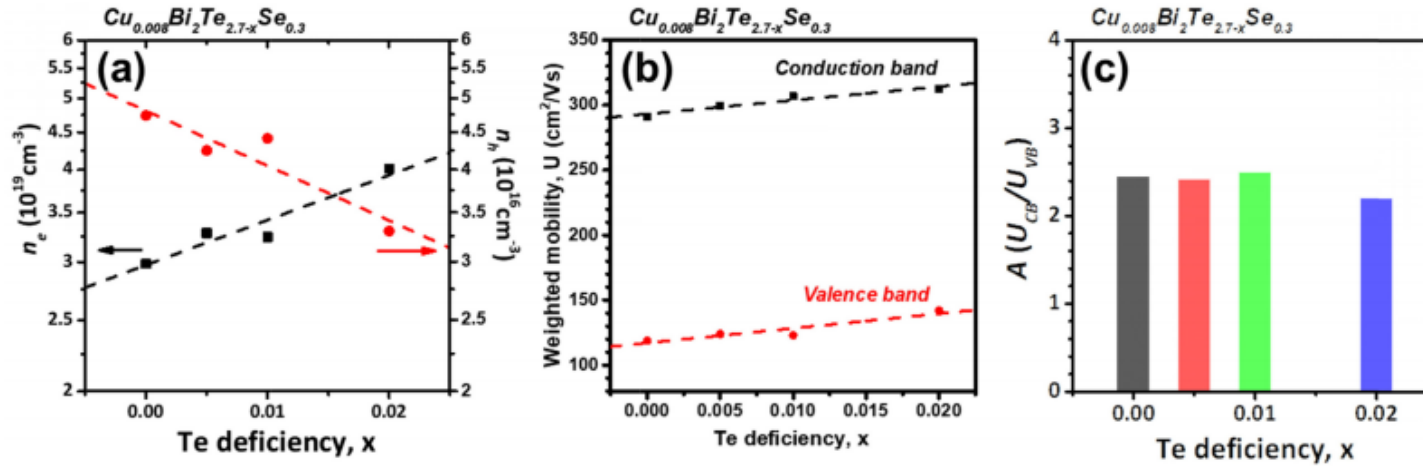


Fig. 7. (a) The electron (n_e) and hole (n_h) concentration, (b) weighted mobility (U) of CB and VB and (c) weighted mobility ratio ($A=U_{\text{CB}}/U_{\text{VB}}$) calculated from SPB at 300K.

Table 1. Band parameters obtained using the two-band model

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		$\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$			
Band parameters		x=0	x=0.005	x=0.01	x=0.02
Conduction band (CB)	CB E_{def} (eV)	18.4	18.0	17.7	17.5
	CB m^* (in m_0)	1.06	1.07	1.08	1.09
	U_{CB} (cm^2/Vs)	291	299	306	313
	Electron conc. n_e (10^{19}cm^{-3})	2.98	3.28	3.24	4.01
Valence band (VB)	VB E_{def} (eV)	29.5	29.0	29.1	27.1
	VB m^* (in m_0)	1	1	1	1
	U_{VB} (cm^2/Vs)	119	124	123	142
	Hole conc. n_h (10^{16}cm^{-3})	4.74	4.25	4.41	3.30
$A (U_{\text{CB}}/U_{\text{VB}})$		2.44	2.42	2.50	2.21

E_{def} = deformation potential

m^* = density-of-states effective mass (m_0 = electron mass)

μ_0 = nondegenerate mobility

U = weighted mobility

A = weighted mobility ratio

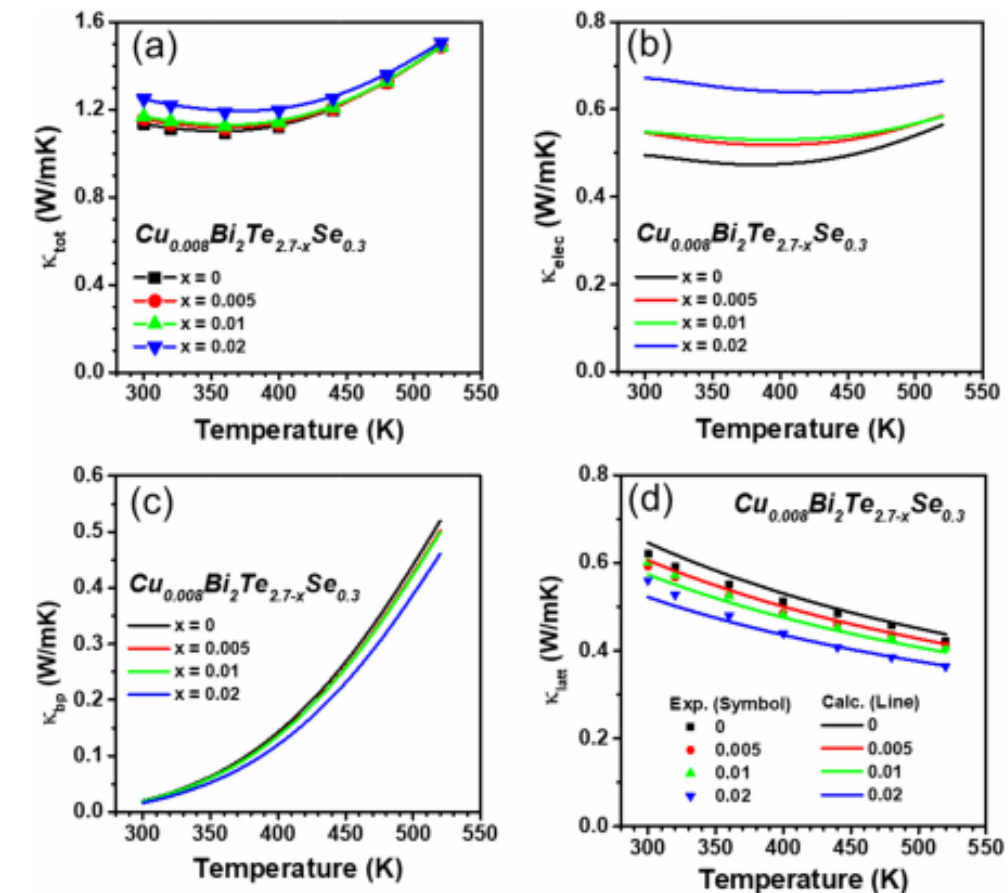


Fig. 8. (a) The total thermal conductivity κ_{tot} , (b) the electronic thermal conductivity κ_{elec} , (c) the bipolar thermal conductivity κ_{bp} , and (d) the lattice thermal conductivity κ_{latt} of the $\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$ with $x=0, 0.005, 0.01$ and 0.02 .

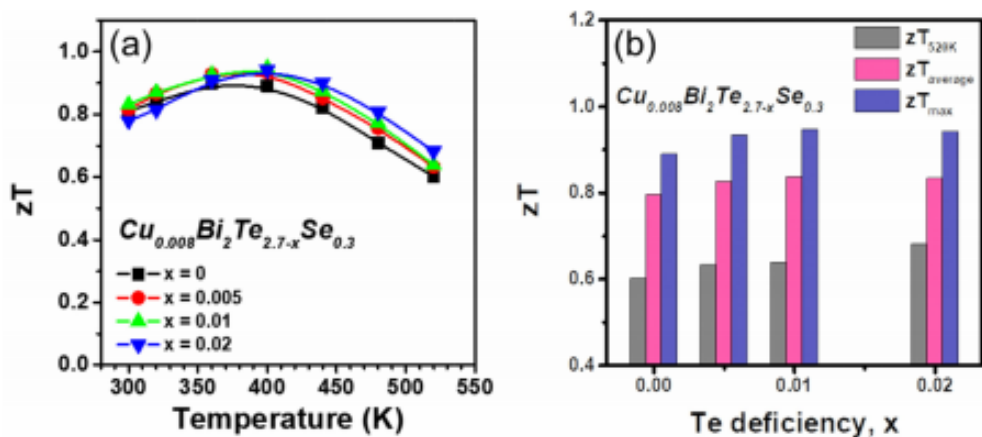


Fig. 5. (a) Temperature dependence of the dimensionless figure of merit zT (b) zT_{520K} , zT_{average} and zT_{max} of the $\text{Cu}_{0.008}\text{Bi}_2\text{Te}_{2.7-x}\text{Se}_{0.3}$ with $x=0, 0.005, 0.01$ and 0.02 .

Thank You