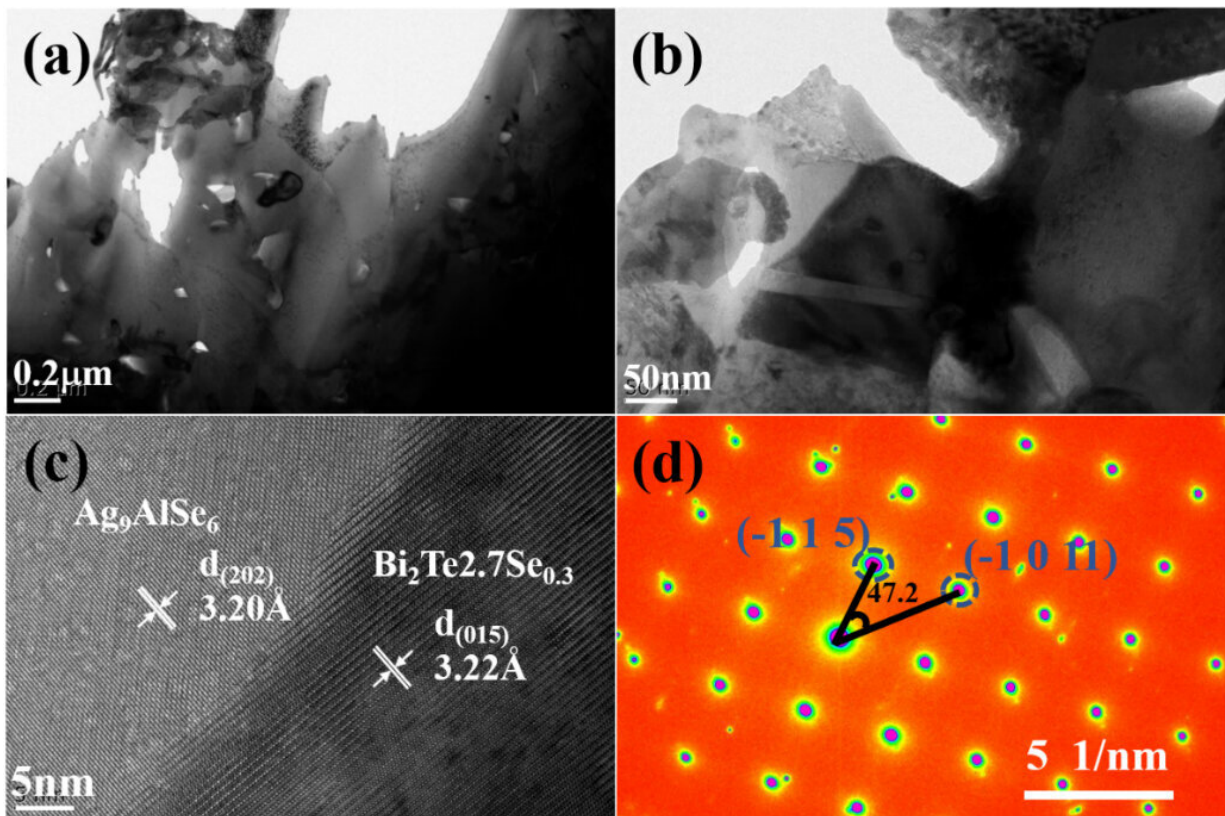


Scientists find novel way to optimize thermoelectric properties of bismuth telluride alloys

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(a) The low magnification TEM image; (b) the medium magnification TEM image; (c) the high magnification TEM image for BTS-0.35Vol% Ag₉AlSe₆; (d) the selected area electron diffraction (SAED) (false-colored); (e-l) the medium magnification TEM image and the EDS mapping for Bi, Te, Se, Ag and Al. Credit: Chen Tao

Recently, a research team led by Prof. Qin Xiaoying from Hefei Institutes of Physical Science of Chinese Academy of Sciences found the thermoelectric properties of N-type $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ (BTS) could be improved by introducing a small amount of Ag_9AlSe_6 nanoparticles into BTS matrix.

The [thermal conductivity](#) of the composite sample with 0.35vol.% Ag_9AlSe_6 was significantly reduced, resulting in a maximum ZT of 1.2 (423K) and an average ZT of 1.1 in the 300-473K temperature range.

The specifics were published in *Inorganic Chemistry Frontiers*.

Thermoelectric devices are composed of P-type and N-type [thermoelectric materials](#). At present, great progress has been made in the improvement of P-type [room temperature](#) thermoelectric material ZT. However, developing high-performance (large ZT) N-type thermoelectric materials near room temperature is more challenging, which hinders the conversion efficiency of [thermoelectric devices](#) and prevents them from being widely used.

Bi_2Te_3 is currently recognized as one of the well-known alloys that can both generate electricity and cool at room temperature. However, the low thermoelectric value ZT and energy conversion efficiency of N-type Bi_2Te_3 limit its commercial application. Therefore, improving the thermoelectric properties of N-type Bi_2Te_3 is of great significance to promote its industrial application.

Finding the optimal second phase is the first and key task to design and manufacture a composite system material with excellent performance (including function and structure). Many studies have explored different dispersed phases of BTS to obtain better thermoelectric performance.

In this research, scientists investigated the thermoelectric properties of

BTS-xvol % Ag_9AlSe_6 ($x= 0, 0.15, 0.25, 0.35, 0.50$ and 0.70) samples by introducing N-type nanoparticles Ag_9AlSe_6 into BTS. The results showed that when Ag_9AlSe_6 nanoparticles were added to BTS, the phonon scattering and phase boundary were enhanced, the Seebeck coefficient was enhanced and the thermal conductivity was reduced.

The thermoelectric performance of composite sample BTS-0.35vol% Ag_9AlSe_6 was improved by about 40% compared with the original BTS, and the ZT_{max} value reaches 1.2 (423K). The average ZT_{ave} of BTS-0.50vol% Ag_9AlSe_6 was 1.1 (300K-473K).

This work showed that the addition of Ag_9AlSe_6 nanoparticles was an effective way to improve the thermoelectric properties of BTS, which was of great significance for the regulation of the thermoelectric properties of N-type bismuth telluride alloys.

More information: Tao Chen et al, Enhancing the thermoelectric performance of n-type $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ through the incorporation of Ag_9AlSe_6 inclusions, *Inorganic Chemistry Frontiers* (2022). [DOI: 10.1039/D2QI01232D](https://doi.org/10.1039/D2QI01232D)

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