Recent discovery of new superconductors including pnictogen atoms

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Since the discovery of iron-based high-$T_c$ superconductors, a compound containing pnictogen atoms is attracting much attention as a candidate of a new superconductor. Recently, we have found various new superconductors containing Bi, P or Sb as follows.

$\text{Ba}_2\text{Bi}_3$ contains planar anionic Bi ribbon nets with four- and three-bonded Bi separated by cationic Ba layers (Fig. 1 (a)). $\text{Ba}_2\text{Bi}_3$ is found to be a superconductor with a $T_c$ of 4.4 K. From the analysis of $\rho(T)$, the Debye temperature $\Theta_D$ and electron-phonon coupling constant $\lambda_{e-p}$ are derived as 75.9 K and 1.0, respectively, indicating that $\text{Ba}_2\text{Bi}_3$ is a superconductor in the strong-coupling regime.

We have succeeded in synthesizing a series of intermetallic ternary phosphide chalcogenide superconductors, $\text{AP}_x\text{X}_3$ ($A = \text{Zr, Hf}; X = \text{S, Se}$) using high-pressure technique. These materials have a PbFCl-type structure (Fig. 1 (b)) when $x$ is greater than 0.3. $T_c$ changes systematically with $x$, yielding dome-like phase diagrams. The maximum $T_c$ is achieved at approximately $x = 0.7$, at which point the $T_c$ is 6.3, 5.5, 5.0 and 4.6 K for $\text{ZrP}_{2-x}\text{Se}_x$, $\text{HP}_{2-x}\text{Se}_x$, $\text{ZrP}_{2-x}\text{S}_x$ and $\text{HP}_{2-x}\text{S}_x$, respectively.

A Au-Sb-Te ternary system crystallizes into a simple cubic structure ($\alpha$-Po-type) (Fig. 1 (c)) when it is quenched from high temperature under high pressure. We found that Au$_{0.125}$Sb$_{0.75}$Te$_{0.125}$ (AuSb$_8$Te) that are reported to be semiconductors above 20 K, is superconductors with a $T_c$ of 6.7 K. The maximum $T_c$ of 8.1 K is achieved for Au$_{0.15}$Sb$_{0.85}$. This $T_c$ value is the highest among materials with the $\alpha$-Po-type structure under ambient pressure.

![Figure 1: Crystal structures of (a)Ba$_2$Bi$_3$, (b)ZrP$_{2-x}$S$_x$, and (c)Au-Sb-Te alloy.](image)

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