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# Ag-Al-Pr (Silver-Aluminum-Praseodymium)

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Zhak et al. [1999Zha] determined an isothermal section for this system at 597 °C (870 K), which depicts eight ternary compounds.

## Binary Systems

The Ag-Al phase diagram [Massalski2] depicts three intermediate phases: $Ag_3Al$ (20.5-29.8 at.% Al; denoted β, body-centered cubic; stable between 778 and ~600 °C), $Ag_2Al$ (22.9-41.9 at.% Al; denoted δ, close-packed hexagonal), and μ (21-24 at.% Al, stable below 450 °C; *A*13, βMn-type cubic). The Ag-Pr phase diagram [2002Oka] has the following intermediate phases: $Ag_5Pr$, $Ag_{51}Pr_{14}$ ($Ag_{51}Gd_{14}$-type hexagonal), $\beta Ag_2Pr$ (hexagonal), $\alpha Ag_2Pr$ ($CeCu_2$-type orthorhombic), and AgPr (*B*2, CsCl-type cubic). The Al-Pr phase diagram [1996Sac] depicts the following intermediate phases: $\beta Pr_3Al_{11}$ ($D1_3$, Al-deficient $Al_4Ba$-type tetragonal), $\alpha Pr_3Al_{11}$ ($\alpha La_3Al_{11}$-type orthorhombic), $PrAl_3$ ($D0_{19}$, $Ni_3Sn$-type hexagonal), $PrAl_2$ (*C*15, $MgCu_2$-type cubic), βPrAl (CeAl-type orthorhombic), αPrAl (ErAl-type orthorhombic), $Pr_2Al$ (*C*23, $Co_2Si$-type orthorhombic), $\beta Pr_3Al$ ($L1_2$, $AuCu_3$-type cubic), and $\alpha Pr_3Al$ ($Ni_3Sn$-type hexagonal).

## Ternary Phases

The known ternary compounds of this system are listed in Table 1 from [1999Zha]. The compounds labeled $\tau_1$ to $\tau_8$

**Table 1 Ag-Al-Pr crystal structure and lattice parameter data [1999Zha]**

| Phase | Composition, at.% | Pearson symbol | Space group | Prototype | Lattice parameter, nm |
|---|---|---|---|---|---|
| $Pr(Ag_{0.54}Al_{0.46})_{11}$ ($\tau_1$) | 49.5 Ag<br>42.1 Al<br>8.3 Pr | *tI*48 | $I4_1/amd$ | $BaCd_{11}$ | $a$ = 1.10262<br>$c$ = 0.70979 |
| $Pr_{1.6}(Ag_{0.43\text{-}0.52}Al_{0.57\text{-}0.48})_{17}$ ($\tau_2$) | 39.3-47.5 Ag<br>52.1-43.9 Al<br>8.6 Pr | *hP*38 | $P6_3/mmc$ | $Ni_{17}Th_2$ | $a$ = 0.93484*<br>$c$ = 0.91033 |
| $Pr_2(Ag_{0.57\text{-}0.68}Al_{0.43\text{-}0.32})_{17}$ ($\tau_3$) | 51-60.85 Ag<br>38.5-28.65 Al<br>10.5 Pr | *hR*19 | $R\bar{3}m$ | $Zn_{17}Th_2$ | $a$ = 0.94129*<br>$c$ = 1.3660 |
| $Pr(Ag_{0.70}Al_{0.30})_5$ ($\tau_4$) | 58.3 Ag<br>25 Al<br>16.7 Pr | hex. | … | $SmAg_{3.5}Al_{1.5}$ | $a$ = 0.54498<br>$c$ = 0.9332 |
| $Pr(Ag_{0.60}Al_{0.40})_5$ ($\tau_5$) | 50 Ag<br>33.3 Al<br>16.7 Pr | *hP*? | $P6_3/mmc$ | $DyAg_{2.4}Al_{2.6}$ | $a$ = 0.9321<br>$c$ = 0.9582 |
| $Pr(Ag_{0.45\text{-}0.56}Al_{0.55\text{-}0.44})_5$ ($\tau_6$) | 37.5-46.7 Ag<br>45.8-36.7Al<br>16.7 Pr | *hP*6 | $P6/mmm$ | $CaCu_5$ | $a$ = 0.5506*<br>$c$ = 0.4417 |
| $Pr(Ag_{0.20\text{-}0.23}Al_{0.80\text{-}0.77})_4$ ($\tau_7$) | 16-18.4 Ag<br>64-61.6 Al<br>20 Pr | *tI*10 | $I4/mmm$ | $Al_4Ba$ | $a$ = 0.4315*<br>$c$ = 1.0865 |
| $Pr(Ag_{0.33}Al_{0.67})_3$ ($\tau_8$) | 25 Ag<br>50 Al<br>25 Pr | *hR*12 | $R\bar{3}m$ | $PuNi_3$ | $a$ = 0.56292<br>$c$ = 2.6915 |
| $Pr_6Ag_{13}Al_{10}$ | 44.8 Ag<br>34.5 Al<br>20.7 Pr | *cF*116 | $Fm\bar{3}m$ | $Th_6Mn_{23}$ | $a$ = 1.3271 |
| $Pr(Ag_{0.26}Al_{0.74})_2$ | 17.3 Ag<br>49.3 Al<br>33.3 Pr | *hP*3 | $P6/mmm$ | $AlB_2$ | $a$ = 0.4216<br>$c$ = 0.42128 |

* Lattice parameters are for $Pr_{1.6}Ag_{8.7}Al_{8.3}$, $Pr_2Ag_{11.4}Al_{5.6}$, $PrAg_{2.42}Al_{2.58}$ and $PrAg_{0.9}Al_{3.1}$ respectively

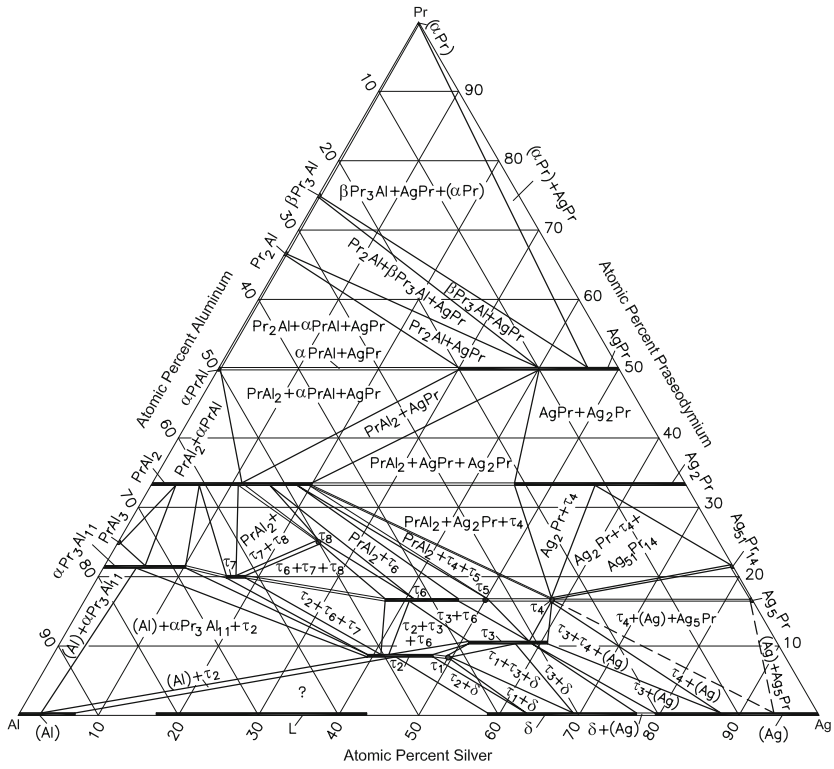


**Fig. 1** Ag-Al-Pr isothermal section at 597 °C [1999Zha]

(denoted 1 to 8 by [1999Zha]) are present at 597 °C (870 K). The last-listed compounds $Pr_6Ag_{13}Al_{10}$ and $Pr(Ag_{0.26}Al_{0.74})_2$ were not found at 597 °C. The ternary solid solutions based on binary compounds $\alpha Ag_2Pr$ and AgPr dissolve 21.3 and 20 at.% Al, respectively. The compounds $\alpha Pr_3Al_{11}$, and $PrAl_2$ dissolve 10.2 and 20 at.% Ag [1999Zha].

## Isothermal Section

With starting metals of 99.99% Ag, 99.99% Al, and 99.5% Pr, [1999Zha] arc-melted 90 alloy compositions in Ar atm. The alloys were annealed at 597 °C for 600-1000 h and quenched in water. The phase equilibria were studied by x-ray powder diffraction. The isothermal section at 597 °C (870 K) constructed by [1999Zha] is redrawn in Fig. 1, to agree with the accepted binary data. A liquid phase L present along the Al-Ag side was omitted by [1999Zha]. The compositions of the ternary phases shown in Fig. 1 are from the listed values of [1999Zha]. $Ag_2Pr$ in Fig. 1 is the low-temperature modification with the $CeCu_2$-type structure.

## References

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