Poster

Quaternary compounds in *R*–*T*–Al–*M* systems

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We are at present carrying out a systematic search for quaternary alumosilicides and alumogermanides containing a rare-earth metal (*R*) and a 3*d*-metal (*T*). Alumosilicides of two compositions, $R_2TAl_4Si_2$, $R_3TAl_3Si_2$, and alumogermanides of four compositions, $RTAl_4Ge_2$, $R_2TAl_4Ge_2$, $R_3TAl_3Ge_2$, $R_5T_3Al_3Ge_4$, were synthesized by arc melting under argon and annealed at 873 K for up to three months. The crystal structures were studied by X-ray powder diffraction. 43 compounds with Si and 92 with Ge were found to adopt the rhombohedral $SmNiAl_4Ge_2$ (Pearson symbol *hR*24, space group *R*-3*m*), tetragonal $Tb_2NiAl_4Ge_2$ (*tI*18, *I*4/*mmm*), hexagonal $Y_3NiAl_3Ge_2$ (*hP*9, *P*-62*m*), or orthorhombic $Er_5Ni_3Al_3Ge_4$ (*oP*30, *Pmmn*) structure types (see the table). The distribution of atoms was in all cases fully ordered.

The formation of rows of isotypic compounds $R_2CoAl_4Si_2$ and $R_3FeAl_3Si_2$ was observed for the first time (shaded in the table). Complete series appear for the late rare-earth elements, sometimes interrupted by the systems with Yb (Sm or Lu). The maximum number of isotypic compounds (85) corresponds to the structure type $Y_3NiAl_3Ge_2$, which is a quaternary substitution variant of the binary type Fe_2P. This structure type is observed not only with transition metals of the iron triad, but also with Mn and Cu.

Rows of isotypic quaternary compounds in *R*–*T*–Al–*M* systems
(+ existence established (* in Lviv); – no isotypic compound observed at 873 K)
[Pearson's Crystal Data, Crystal Structure Database for Inorganic Compounds, Release 2023/24, Eds. P. Villars, K. Cenzual, ASM International, Materials Park, Ohio, USA]

Structure type	*T*	*R*									
		Y	Sm	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Alumosilicides											
$Tb_2NiAl_4Ge_2$	Co	+*	–	+*	+*	+*	+*	+*	+*	–	+*
$Y_3NiAl_3Ge_2$	Fe	+*	+*	+*	+*	+*	+*	+*	+*	–	+*
	Co	+*	+*	+*	+*	+*	+*	+*	+*	–	+*
	Ni	+*	–	+*	+*	+*	+*	+*	+*	–	+*
	Cu	+*	+*	+*	+*	+*	+*	+*	+*	–	+*
Alumogermanides											
$SmNiAl_4Ge_2$	Ni	+	+	+*	+*	+*	+*	+*	+*	–	+*
$Tb_2NiAl_4Ge_2$	Fe	+*	+*	+*	+*	+*	+*	+*	+*	–	+*
	Co	+*	+*	+*	+*	+*	+*	+*	+*	+*	+*
	Ni	+*	+*	+*	+	+*	+*	+*	+*	+*	–
$Y_3NiAl_3Ge_2$	Mn	+*	+*	+*	+*	+*	+*	+*	+*	+*	+*
	Fe	+*	+*	+*	+*	+*	+*	+*	+*	+*	+*
	Co	+*	+*	+*	+*	+*	+*	+*	+*	+*	+*
	Ni	+	+*	+*	+*	+*	+*	+*	+*	+*	+*
	Cu	+*	+*	+	+	+*	+*	+*	+*	+*	+*
$Er_5Ni_3Al_3Ge_4$	Ni					+*	+*	+*	+*	+*	

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