SECTIONS OF TERNARY DIAGRAMS
RARE EARTHS–INDIUM–TIN
OF R(In$_{1-x}$Sn$_x$)$_3$ COMPOSITION

G. A. Costa and E. A. Franceschi

ISTITUTO DI CHIMICA FISICA,
UNIVERSITÀ DI GENOVA, GENOVA, ITALY

Results of thermal studies on Nd(In$_{1-x}$Sn$_x$)$_3$ and Gd(In$_{1-x}$Sn$_x$)$_3$ solid solutions are reported, together with those of structural studies on R(In$_{1-x}$Sn$_x$)$_3$ (R = Nd, Sm, Gd, Tb, Dy, Er, Tm). The non linear behaviour of the lattice parameters and the shape of the phase diagrams are compared. The peritectic decomposition of tin-rich phases of Gd(In$_{1-x}$Sn$_x$)$_3$ is pointed out. The necessity of high pressure studies of these solid solutions is outlined.

The compounds of formula RM$_3$ (R = rare earths; M = In, Sn) crystallize in the cubic AuCu$_3$ type structure [1], but RSn$_3$ phases can be synthesized at standard pressure only to gadolinium, with the exception of YbSn$_3$ [2]. Miller & Hall [3], however, were able to synthesize under increasingly higher pressures also TbSn$_3$, DySn$_3$, HoSn$_3$ and ErSn$_3$. At room temperature and pressure these phases are isotypic with the other rare earth tritin compounds and a strong correlation between the cell parameters of the RSn$_3$ compounds and the ionic (3+) radii of the rare earth elements can be found [3, 4].

The purpose of this work is to investigate the variation of the lattice parameter in R(In$_{1-x}$Sn$_x$)$_3$ solid solution vs. the tin content, and to correlate such a variation with the shape of the corresponding phase diagram.

Experimental

The starting materials used to prepare the alloys were In and Sn (5N pure) and R (2N5 pure), obtained from Koch–Light Co.

The samples (each of a mass of about 1 g) were obtained by direct synthesis. The two metals were compressed together and sealed in Mo crucibles under pure argon and were melted in an induction furnace while being carefully shaken to ensure homogeneity. This method avoided the necessity of chemical analysis of the samples as no losses were sustained. Differential thermal analysis (DTA) was performed for each alloy at heating and cooling rates of 5 or 10 deg/min (the accuracy was ± 5 deg).
In a few cases to ensure thermal equilibrium lower cooling rates were necessary. In other cases annealing treatments were also performed.

The alloys showed a grey metallic lustre; the oxidizability increased regularly with decreasing indium content. The microstructures of as-cast or heat treated alloys were examined using standard metallographic techniques. The microhardness of the alloys was determined by the Vickers’ method using a Leitz-Durimet hardness tester. The load used was 25 grams.

The crystal structure analyses were performed by means of the powder method, using Cu Kα radiation. The intensity calculations for the powder patterns were carried out using the Lazy Pulverix program [5].

**Results and discussion**

As the structure of the pure components of RM₃ is the same, the chemical properties are similar and the lattice parameters are only slightly different (~ 1%), we can expect complete solubility between RIn₃ and RSn₃, possibly obtained by high pressure synthesis.

An extended solid solubility of the compounds of formula R(In₁₋ₓSnₓ)₃ was already pointed out in a previous work [6] also for R = Tb, Dy, Ho, Er and Tm.

The behaviour of the reticular parameters with the tin content is not linear (i.e. it does not follow Vegard’s law) for all the solid solutions considered (Fig. 1). A well

![Fig. 1 Trend of the lattice parameters vs. the tin content in the solid solutions R(In₁₋ₓSnₓ)₃](image)

- = lattice parameters for RM₃ pure components at standard pressure.
○ = lattice parameters for the RSn₃ phases obtained under pressure [3]

*J. Thermal Anal. 34, 1988*