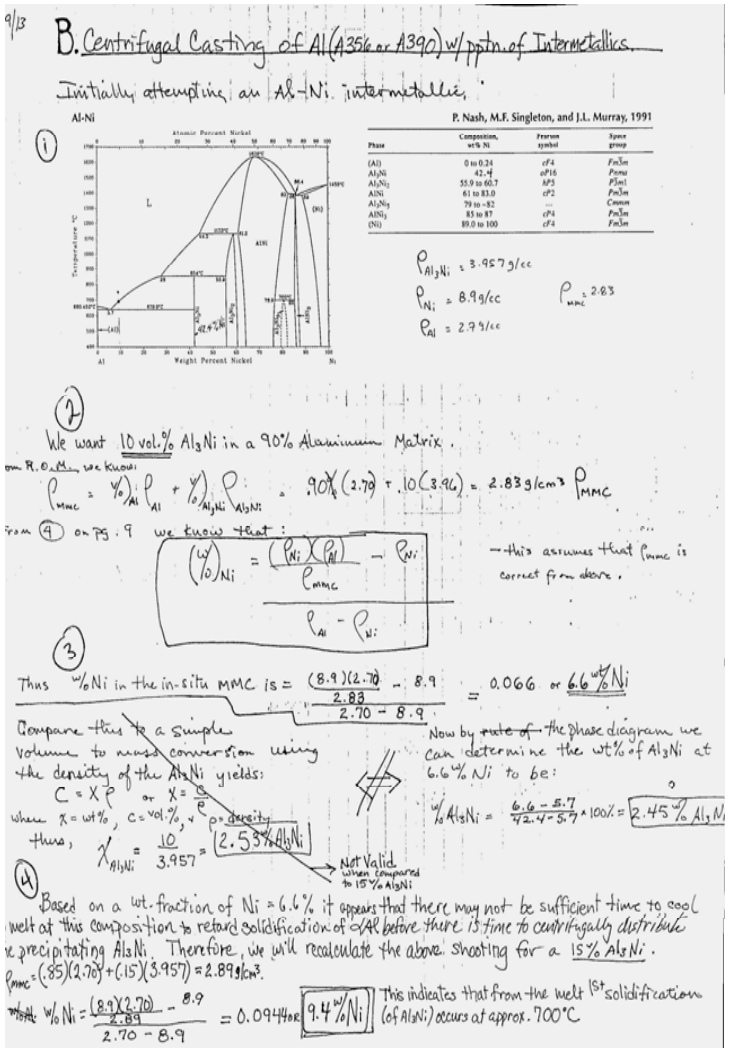
MATERIALS SCIENTIST



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B. Centrifugal Casting of Al (A356 or A390) w/ pptn. of Intermetallics.

Initially attempting an Al-Ni intermetallic.

(1)

Al-Ni

P. Nash, M.F. Singleton, and J.L. Murray, 1991

Phase	Composition, wt% Ni	Pearson symbol	Space group
(Al)	0 to 0.24	cF4	$Fm\bar{3}m$
Al_3Ni	42.4	oP16	Pnma
Al_3Ni_2	55.9 to 60.7	hP5	$P\bar{3}m1$
AlNi	61 to 83.0	cP2	$Pm\bar{3}m$
Al_3Ni_5	79 to ~82	...	Cmmm
$AlNi_3$	85 to 87	cP4	$Pm\bar{3}m$
(Ni)	89.0 to 100	cF4	$Fm\bar{3}m$

$\rho_{Al_3Ni} = 3.957\ g/cc$

$\rho_{Ni} = 8.9\ g/cc$ $\rho_{MMC} = 2.83$

$\rho_{Al} = 2.7\ g/cc$

(2)

We want 10 vol.% Al_3Ni in a 90% Aluminum Matrix.

From R.O.M. we know:

$\rho_{MMC} = \%_{Al}\rho_{Al} + \%_{Al_3Ni}\rho_{Al_3Ni} = .90(2.70) + .10(3.96) = 2.83\ g/cm^3\ \rho_{MMC}$

From (4) on pg. 9 we know that:

$$\boxed{\left(\%\right)_{Ni} = \frac{\frac{(\rho_{Ni})(\rho_{Al})}{\rho_{MMC}} - \rho_{Ni}}{\rho_{Al} - \rho_{Ni}}}$$

— this assumes that ρ_{MMC} is correct from above.

(3)

Thus $\%Ni$ in the in-situ MMC is $= \frac{\frac{(8.9)(2.70)}{2.83} - 8.9}{2.70 - 8.9} = 0.066$ or $6.6\ \%Ni$

Compare this to a simple volume to mass conversion using the density of the Al_3Ni yields:

$C = X\rho$ or $X = \frac{C}{\rho}$

where X = wt%, C = vol.%, ρ = density

thus, $X_{Al_3Ni} = \frac{10}{3.957} = \boxed{2.53\ \%Al_3Ni}$ → Not Valid when compared to 15% Al_3Ni

Now by ~~rule of~~ the phase diagram we can determine the wt% of Al_3Ni at 6.6% Ni to be:

$\%Al_3Ni = \frac{6.6 - 5.7}{42.4 - 5.7} \times 100\% = \boxed{2.45\ \%Al_3Ni}$

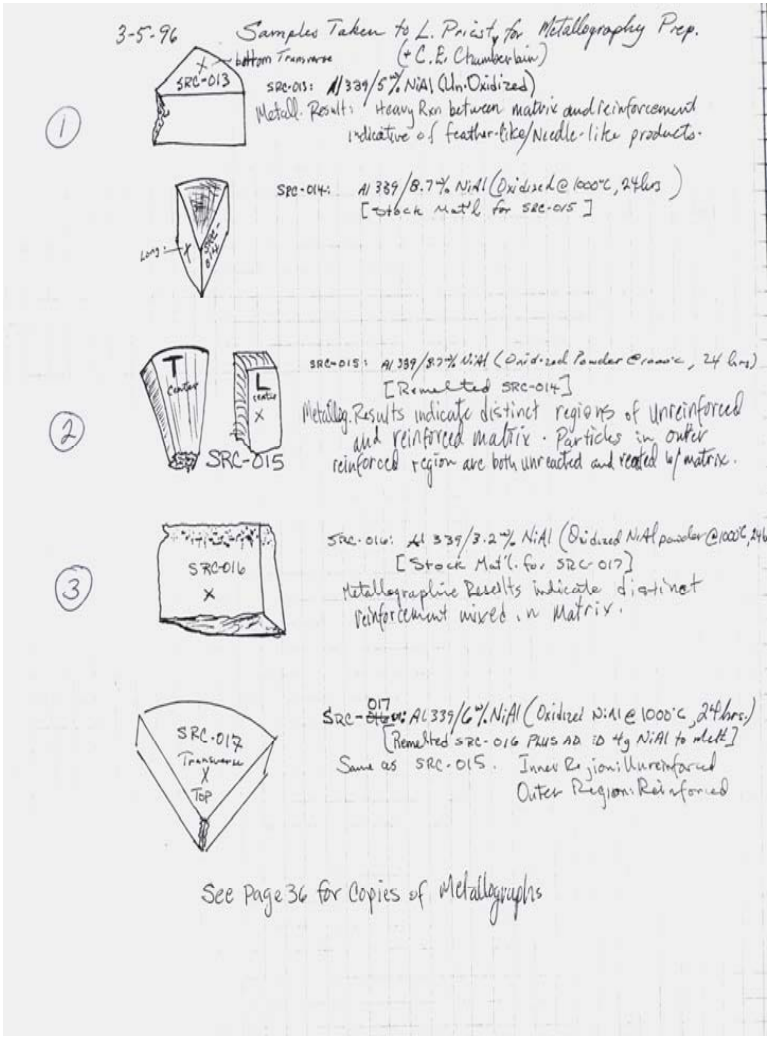
(4)

Based on a wt. fraction of Ni = 6.6% it appears that there may not be sufficient time to cool melt at this composition to retard solidification of α/Al before there is time to centrifugally distribute the precipitating Al_3Ni. Therefore, we will recalculate the above shooting for a 15% Al_3Ni.

$\rho_{MMC} = (.85)(2.70) + (.15)(3.957) = 2.89\ g/cm^3$.

$\%Ni = \frac{\frac{(8.9)(2.70)}{2.89} - 8.9}{2.70 - 8.9} = 0.0944$ or $\boxed{9.4\ \%Ni}$

This indicates that from the melt 1st solidification (of Al_3Ni) occurs at approx. 700°C



3-5-96 Samples Taken to L. Priest for Metallography Prep. (+ C.E. Chamberlain)

(1)

bottom Transverse

SRC-013

SRC-013: Al 339/5% NiAl (Un-Oxidized)

Metall. Result: Heavy Rxn between matrix and reinforcement indicative of feather-like/Needle-like products.

SRC-014: Al 339/8.7% NiAl (Oxidized @ 1000°C, 24 hrs) [Stock Mat'l for SRC-015]

Long

(2)

T center

L center

SRC-015

SRC-015: Al 339/8.7% NiAl (Oxidized Powder @ 1000°C, 24 hrs) [Remelted SRC-014]

Metallog. Results indicate distinct regions of unreinforced and reinforced matrix. Particles in outer reinforced region are both unreacted and reacted w/ matrix.

(3)

SRC-016

SRC-016: Al 339/3.2% NiAl (Oxidized NiAl powder @ 1000°C, 24h [Stock Mat'l. for SRC-017]

Metallographic Results indicate distinct reinforcement mixed in Matrix.

SRC-017 Transverse Top

SRC-017: Al 339/6% NiAl (Oxidized NiAl @ 1000°C, 24 hrs.) [Remelted SRC-016 PLUS AD ID 4g NiAl to melt]

Same as SRC-015. Inner Region: Unreinforced Outer Region: Reinforced

See Page 36 for Copies of Metallographs

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