Blending Cast Bullet Antimony Alloys, Alloying with Roto Metals Super Hard

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Roto Metals, Inc. of San Leandro, CA has recently done a tremendous favor and service for bullet casters with the introduction of *Roto Metals Super Hard Alloy*. It is now a simple matter to blend (alloy) a limitless variety of lead/antimony alloys to suit your needs, it opens up a whole new world of possibilities for bullet alloys and bullet casters.

Super Hard is a 70% lead (Pb), 30% antimony (Sb) alloy that is used to increase the antimony percentage (harden the alloy) of your current lead supply such as clip-on and stick-on (tape type) wheel weight, plumbers lead, sheet lead and many other lead alloys. It is made with virgin metals, not from scrap metals so you are adding perfectly "clean", new alloy to your casting pot. With the addition of pure bar tin from Roto Metals the sky is the limit and you take control of your casting alloys, even with many scrap lead alloys.

Antimony (Sb). It is the current metal used to strengthen/harden lead alloys for bullet casters and for numerous applications in the metals industry. It is an extremely brittle metal but has unique characteristics in a lead alloy in addition to its basic hardening, such as the ability to heat treat a lead alloy bringing the final hardness up far more than what the percentage of antimony would suggest. Alloys such as monotype (19% Sb) and stereotype (23% Sb) are so brittle because of their *extremely high Sb* percentages, bullets cast of them can actually break in two by simply chambering a round or dropping it on a cement floor. Antimony is a valuable part of the bullet casters alloy but too much of a good thing is clearly not a good thing. Super Hard is for blending (alloying) with softer lead or lead alloys, never try to cast bullets with Super Hard alone, you will not be a happy camper.

Antimony is a silver white metal, very hard and very brittle. It has no characteristic crystallographic surfaces when sheared. Melting temperature is 1167° ^{F} and even when melted at or above that temperature it is not easy to get a homogeneous alloy with lead. In addition, Sb in it's pure or powdered form is highly toxic and proper breathing apparatus and proper and thorough clean up afterwards is necessary. So what to do? Antimony is an important part of many bullet casting alloys but it's both difficult and could even be dangerous to try to alloy yourself. Here is one of the real services provided by Roto Metals; the professionals have done the difficult and dangerous part of alloying Pb/Sb for you. Super Hard melts at about 650$^{o\,F}$, is homogeneous with your base alloy and thus blends in with your melt quickly and easily with your final flux before casting.

Weight and Size differences. As the percentages of the alloys in a melt change other changes occur in addition to the weight of the bullet. In general the higher the percentage of Sb the larger the as cast diameter of the bullet and the larger the diameter of the bullet the more increase there is. In other words a 45 caliber bullet will show more of an increase than a .308" caliber bullet (table 3). In addition, the alloy percentages have a direct effect on the final sized diameter (table 1). I imagine the sizer die makers get daily phone calls from customers complaining (as an example) that their .309" die sizes to .3084" and not .309". If you change the alloy the weight, as cast diameter, shrinkage, sized diameter and BHN all change. Higher Sb percentages also result in less shrinkage as the bullet cools and it's possible for this simple fact to result in bullets that are a bit tougher to get to fall from the mold (table 2). From the tables it can also be seen that in reverse the softer the alloy (less Sb) and the larger the diameter of the bullet that *more* shrinkage will occur.

Sb and Brittleness. As you have already read, raising the Sb percentage makes bullets brittle so the key is to not get carried away, your intended target should guide you to the maximum percent of Sb in an alloy. Look over the recipes I listed below and you'll notice that in only Hardball (6% Sb) and Lyman #2 (5% Sb) and 1 other (Alloy #2-1) did I go over 5% Sb and #2-1 is still under 5.5%. The vast majority of smokeless powder handgun and rifle loads should be well served with these Sb percentages. Hollow points intended for hunting/expansion should be about 2% Sb and 2% Sn. Thanks to Super Hard this is now fairly easy to dial in.

The tin (Sn) in your melt. Sb oxidizes rapidly when in contact with air and the Sn in your melt helps inhibit this oxidation in melts up to about 750 degrees. With higher temps than this tin itself oxidizes much more rapidly and looses much of it's ability to inhibit Sb and Pb oxidation. It's not only the surface of the top of the melt in your pot that's in contact with air but also the stream of alloy from a bottom pour pot or even from a ladle that Sb will also oxidize, the hotter the alloy the faster the oxidation. This stream of alloy into your mold is where tin will play it's most effective roll in reducing the oxidation of Sb. By reducing the oxidation of both Sb/Pb tin reduces the surface tension of the melted alloy which enables your alloy to fill in the smallest corners and angles inside the mold resulting in well filled out bullets. The addition of 1 or 2% Sn is very beneficial when adding Sb to your alloy.

The Base Metals. All clip-on wheel weight (CWW) recipes and percentages used in these recipes are based on the assumption that CWW has 2% Sb and 0.5% Sn plus a trace of arsenic (As). Additional tin in the below recipes added as pure bar tin. My batch of CWW (several batches blended together for a single uniform batch) with 2% Sn added tests 11-12 BHN.

All stick-on (tape weights) (SWW) recipes and percentages used in these recipes are based on the assumption that SWW has 0% Sb and 0.5% Sn. SWW has no arsenic (As), it will HT with Sb added (Pb/Sb alloy) but not to the same extent as an Pb/Sb/As alloy. Additional tin in the below recipes added as pure bar tin. My batch of SWW (several batches blended together for a uniform single batch) tests 6 BHN.

The percentages of WW alloy are assumptions because wheel weight alloy is scrap metal, there is no exact formula for making the weights and percentages vary not only from company to company but even from batch to batch within the same manufacturer as the price of and availability of raw materials change. By using these "assumed" percentages your alloy will be reasonably close to the below recipes even with some variability with your wheel weight alloy.

All of the below recipes use either clip-on or stick-on wheel weight as the base metal. These recipes are but a minor sampling of what alloys Super Hard can be blended into, get out your wizards' cap and calculator and see what you can create to better suit your shooting needs. For the most part the below recipes were designed to allow me to experiment with final air cooled hardness, the aging time curve, as cast diameters, compare the differences and test to see what useful range 6 BHN SWW could be while keeping the Sb percentage reasonable.

Super Hard / WW Recipes

(Where no as cast weight or BHN given in below recipes alloy not yet blended by author)

Alloy 1 — Clip-on WW + Roto Metals Super Hard — Alloy 2

15 lb CWW / 1 lb Super Hard

Lead	107275 Gr.	**92.75%**	Lead	107275 Gr.	**92.75%**
Antimony	4200 Gr.	**3.64%**	Antimony	4200 Gr.	**3.64%**
Tin	4165 Gr.	**3.77% (9.5 ounces)**	Tin	2082.5 Gr.	**1.8% (4.77 ounces)**
Total weight	16.52 lb		Total weight	16.225 lb	

Alloy #1 cast with Lyman #311672 @ 160.0 Gr. (average weight) and air cooled tested 14 BHN with the LBT BHN tester on the second day after casting - 15 BHN on day 3 - 15 BHN on day 4 - 15 BHN on day 5.

Alloy #2 cast with Lyman #311672 @ 161.0 Gr. (average weight) and air cooled tested 11 BHN with the LBT BHN tester on the second day after casting - 12 BHN on day 3. The only difference between #1 & #2 is the Sn percentage. Does additional Sn harden the alloy? It appears so and testing this was the purpose of making #2 identical to #1 except the Sn percentage.

Sn % added to combined Pb/Sb wgt. Sb % added to Pb wgt.

Trace of (As) From CWW - 1 lb CWW = 6825 Gr Pb, 35 Gr Sn - 1 lb SH = 4900 Gr Pb, 2100 Gr Sb

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Alloy 1-1 — Clip-on WW + Roto Metals Super Hard — Alloy 2-1

Alloy 1-1: Alloy not made

Alloy 2-1: 15 lb CWW / 2 lb Super Hard

Lead	Lead	112175 Gr.	**92.65%**
Antimony	Antimony	6004 Gr.	**5.35%**
Tin	Tin	1930 Gr.	**1.8% (4.4 ounces)**
Total weight	Total weight	17.48 lb	

Alloy #2-1 cast with Lyman #311672 @ 159.3.0 Gr. (average weight) and air cooled tested 13 BHN with the LBT BHN tester on the second day after casting, in 2 weeks it remained 13 BHN, in 30 days it reached 14 BHN. Alloy #2-1 was made by adding 1 pound SH and 313 Gr. Sn to alloy #2, Sn added to bring the Sn % up to 2%.

Sn % added to combined Pb/Sb wgt. Sb % added to Pb wgt.

Trace of (As) From CWW - 1 lb CWW = 6825 Gr Pb, 35 Gr Sn - 1 lb SH = 4900 Gr Pb, 2100 Gr Sb

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Alloy 3 — Stick-on WW + Roto Metals Super Hard — Alloy 4

15 lb SWW / 2 lb Super Hard

Lead	114275 Gr.	**92.6%**	Lead	114275 Gr.	**94.51%**
Antimony	4200 Gr.	**3.66%**	Antimony	4200 Gr.	**3.66%**
Tin	4200 Gr.	**3.55% (9.6 ounces)**	Tin	2100 Gr.	**1.77% (4.8 ounces)**
Total weight	17.5 lb		Total weight	17.2 lb	

SWW - No (As) in SWW alloys, will HT but not to the same degree as an (As) alloy.

Sn % added to combined Pb/Sb wgt. Sb % added to Pb wgt.

1 lb SWW = 6965 Gr Pb, 35 Gr Sn - 1 lb SH = 4900 Gr Pb, 2100 Gr Sb. Sn % added to combined Pb/Sb wgt.

Alloy 5 — Stick-on WW + Roto Metals Super Hard — Alloy 6

15 lb SWW / 1 & 1.5 lb Super Hard

***1 Pound Super Hard**			**1.5 Pound Super Hard**		
Lead	109375 Gr.	**96.3%**	Lead	111825 Gr.	**95.1%**
Antimony	2100 Gr.	**1.84%**	Antimony	3150 Gr.	**2.82%8**
Tin	2100 Gr.	**1.88% (4.8 ounces)**	Tin	2236 Gr.	**1.95% (5.1 ounces)**
Total weight	16.25 lb		Total weight	16.75 lb	

Alloy #6 cast with Lyman #311672 @ 162.5 Gr. (average weight) and air cooled tested 11 BHN with the LBT BHN tester in 24 hours after casting.

*This recipe (alloy #5) is very close to straight CWW Pb/Sb with about 1.5% added tin and no As.

Sn % added to combined Pb/Sb wgt. Sb % added to Pb wgt.

SWW - No (As) in SWW alloys, will HT but not to the same degree as an (As) alloy.

1 lb SWW = 6965 Gr Pb, 35 Gr Sn — 1 lb SH = 4900 Gr Pb, 2100 Gr Sb

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Alloy 7 — **Stick-on WW + Roto Metals Super Hard** — **Alloy 8**

15 lb SWW / 2 & 2.5 lb Super Hard

2 Pound Super Hard			2.5 Pound Super Hard		
Lead	114275 Gr.	**94.32%**	Lead	116725 Gr.	**93.55%**
Antimony	4200 Gr.	**3.68%**	Antimony	5250 Gr.	**4.45%**
Tin	2369.5 Gr.	**2% (5.4 ounces)**	Tin	2460 Gr.	**2% (5.63 ounces)**
Total weight	17.25 lb		Total weight	17.9 lb	BHN, Min 2 days 13
Alloy #7 cast with Lyman #311672 @ 161.5 Gr. (average weight) and air cooled tested 12 BHN with the LBT BHN tester 3 days after casting.					
Alloy #8 cast with Lyman #311672 @ 161.0 Gr. (average weight) and air cooled tested 13 BHN with the LBT BHN tester 2 days after casting. Alloy #8 was made by adding 1/2 pound Sb and 69.5 Gr. Sn (to keep the Sn percentage at 2%) to alloy #7.					
SWW - No (As) in SWW alloys, will HT but not to the same degree as an (As) alloy.					
1 lb SWW = 6965 Gr Pb, 35 Gr Sn			1 lb SH = 4900 Gr Pb, 2100 Gr Sb		
Sn % added to combined Pb/Sb wgt. Sb % added to Pb wgt.					

Alloy 9 Hardball From 6 BHN SWW — **Stick-on WW + Roto Metals Super Hard** — **Alloy 10 Lyman #2 From 6 BHN SWW**

15 lb SWW / 3.34 - 3 lb Super Hard

3.34 Pound Super Hard			3 Pound Super Hard		
Lead	121380 Gr.	**92%**	Lead	**125475 Gr.**	**90%**
Antimony	7282 Gr.	**6%**	Antimony	**6273.75 Gr.**	**5%**
Tin	2427 Gr.	**2% (5.5 ounces)**	Tin	**6273.75 Gr.**	**5% (14.3 ounces)**
Total weight	18.75 lb	**BHN, Min 2 days 12**	Total weight	19.72 lb	
Alloy #9 cast with Lyman #311672 @ 161.0 Gr. (average weight) and 12 BHN in 48 hours.					
Alloy #10					
SWW - No (As) in SWW alloys, will HT but not to the same degree as an (As) alloy.					
1 lb SWW = 6965 Gr Pb, 35 Gr Sn			1 lb SH = 4900 Gr Pb, 2100 Gr Sb		
Sn % added to combined Pb/Sb wgt. Sb % added to Pb wgt. *2% Sn added to total wgt., could be 2% to 2.5% Sn.					

Alloy 11 — **Stick-on WW + Roto Metals Super Hard** — **Alloy 12**

18 lb SWW / 9.4 ounces & ? lb Super Hard

9.4 ounces Super Hard			Pound Super Hard		
Lead	126000 Gr.	**94.7%**	Lead	Gr.	**%**
Antimony	4112 Gr.	**3.3%**	Antimony	Gr.	**%**
Tin	2380 Gr.	**2% (5.4 ounces)**	Tin	Gr.	**%**
Total weight	18.9 lb	**BHN, Min 2 days 12**	Total weight	16.75 lb	
Alloy #11 cast with RCBS 44 cal. 245 Gr. PB SWC @ 156.5 Gr. (average weight w/o lube) and air cooled tested 8 BHN with the LBT BHN tester on day of casting and 10 BHN in 24 hours - in 48 hours.					
Sn % added to Pb wgt. Sb % added to Pb wgt.					
Alloy #12					
SWW - No (As) in SWW alloys, will HT but not to the same degree as an (As) alloy.					
1 lb SWW = 6965 Gr Pb, 35 Gr Sn			1 lb SH = 4900 Gr Pb, 2100 Gr Sb		

Notes, conclusions & surprises:

Notes & conclusions on alloys 1 and 2:

Alloys #1 & #2, blended from the same lot of clip-on WW, the only difference is the percentage of added tin with alloy #1 having 3.77% and alloy #2 having 1.8% and yet there is marked difference in age hardening. In fact alloy #2 BHN in two days is basically the same BHN as the base metal even though 1 pound of Super Hard was added to 15 pounds CWW doubling the amount of Sb.

Notes & conclusions on alloys 3 and 4:
Neither alloy blended as of this writing.

Notes & conclusions on alloys 5 and 6:
Alloy #5 not yet blended.
Alloy #6 took 6 BHN SWW to 11 BHN in 2 days, basically air cooled CWW BHN.

Notes & conclusions on alloys 7 and 8:
Alloy #8 was blended by adding 0.5 pound Super Hard and enough Sn to keep the percentage at 2% to alloy #7. The modest gain over alloy #7 in BHN for alloy #8 is not an economical use of the Super Hard.

Notes & conclusions on alloy 9:
Got SWW or other soft lead alloy? With Super Hard you can turn your soft alloy into Hardball at far less cost than purchasing hardball alloy. Using round numbers and the costs of Hardball vs. the cost of Super Hard and tin at the prices as of this writing the cost to make your own is less than $0.80 per pound for the nearly 19 pounds in the recipe. Hardball is currently on sale at Roto Metals for $2.02 per pound plus shipping. At Midway USA hardball is $3.78 per pound.

Notes & conclusions on alloy 10:
The 20 pounds of Lyman #2 in the recipe will cost about $22.00 to make ($1.10 per pound) assuming you already have the soft lead. By contrast Roto Metals (as of this writing) has Lyman #2 on sale @ $2.32 per pound, the regular price is $2.73 per pound with free shipping if your order is over $100.00, Midway USA does not list Lyman #2.

Notes & conclusions on alloy 11:
Alloy 11 blended looking for 8-10 BHN alloy from 6 BHN SWW for the 44 Spl. I had 18 pounds of SWW +2% Sn in the pot and I had a 9.4 ounce piece of SH resulting in alloy 11.

(Table 1) **Bullet alloy as-cast & final dia. w/.308 sizing die**

	Lead	Wheel Weights	Lyman #2	Linotype
As-cast dia.	.309"	.3095"	.310"	.3104"
Sized dia.	.3078"	.3079"	.3084"	.3084"

(table 2) **Alloy shrinkage of cast bullets**

Composition, %					Shrinkage
Type of alloy	**Tin**	**Antimony**	**Lead**	**BHN**	**Linear, %**
Linotype	4	12	84	18	.65
Monotype	9	19	72	26	.65
Antimony	--	100	--	50	.47
Lead	--	--	100	5	1.13
Tin	100	--	--	7	.90

(table 3)

Shrinkage - Bullet Diameter, Inches			
Alloy	.308	.357	.452
Linotype	.002	.0025	.003
Lyman # 2	.0025	.0025	.0035
Soft Lead	.0035	.004	.005

Key to symbols/abbreviations used in this article.

Metal	Symbol	Abbreviations	
Lead	Pb	CWW	Clip-on Wheel Weight (w/2% Sn 11-12 BHN)
Antimony	Sb	SWW	Stick-on Wheel Weight (Tape Weights) (Straight SWW 6 BHN).
Tin	Sn	WW	Wheel Weight.
Arsenic	As	SH	Super Hard Alloy (Roto Metals).
		lb	Pounds.
		BHN	Brinell Hardness Number.
		HT	Heat Treat, quenching from the mold or oven heat treating.
		Gr.	Grains, (7,000 Gr. = 1pound)

Conversion factors:

To convert grains to ounces multiply grains by .00229, example from alloy #1 above, 4044 Gr Sn X .00229 = 9.26 ounces. (rounded off to nearest 100th of an ounce).

To convert ounces to grains multiply ounces by 437.5, example from alloy #1, 9.26 ounces Sn x 437.5 = 4051 Gr (rounded off to nearest 100th of an ounce).

Roto Metals Super Hard = 70% Pb - 30% Sb / 1lb Super Hard = 4900 Gr Pb / 2100 Gr Sb.
Roto Metals bar tin = 99.9% Pure.

Note: You could create the above alloy recipes by converting to ounces rather than grains, however, there are 16 ounces to a pound and 7000 Gr to a pound, any rounding off or minor errors using ounces would create fairly large variations in pot to pot alloy percentages (consistency). A 10% error (or rounding off) with grains is a 70 Gr variation for the entire pot of alloy. A 10% error using ounces is 1.6 ounces or 700 Gr. By converting to grains and rounding off to hundreds of an ounce such variations are statistically irrelevant.

Roto Metals bar tin / 99.9% Pure.
Roto Metals Super Hard = 70% Pb - 30% Sb / 1lb Super Hard = 4900 Gr Pb / 2100 Gr Sb.