

Recycling Aluminum Aerospace Alloys

Subodh K. Das*
Secat Inc.
Lexington, Kentucky

Cost-effective means are needed for recycling aluminum alloys in private, civil, and military aircraft. The principal challenges that must be solved in creating this ideal aircraft-recycling scenario include:

- Identifying decision options for dismantling aircraft to simplify recycling
- Identifying and optimizing technologies for automated shredding, sorting, and remelting of those 2xxx and 7xxx alloys with relatively high levels of alloying elements (sometimes in excess of 10%)
- Identifying the range of representative compositions possible from recycling aircraft components



Immediately after World War II, the Army's San Antonio Air Technical Service Command established a storage facility for B-29 and C-47 aircraft at Davis-Monthan AFB in Arizona. Today, this facility is the Aerospace Maintenance and Regeneration Group (AMARG), which has grown to include more than 4200 aircraft and 40 aerospace vehicles from the Air Force, Navy-Marine Corps, Army, Coast Guard, and several federal agencies including NASA. The chief reasons for selecting Davis-Monthan were Tucson's meager rainfall, low humidity, and alkaline soil. In addition, the soil (called caliche) is hard, making it possible to park aircraft in the desert without constructing concrete or steel parking ramps. www.dm.af.mil

Identifying the combination of performance requirements and compositions that would make useful aircraft components from recycled metal, even though they may not achieve the highest attainable levels of toughness

These challenges include many of the general issues of aluminum recycling. Progress is being made in the application of laser-induced breakdown spectroscopy (LIBS) for shredding and sorting of some aluminum alloys. However, little or nothing has yet been done to apply recycling technology to shredding, sorting, and reuse of recycled metal from obsolete aircraft and space vehicle components.

*Fellow of ASM International

Implementation issues include:

- Dismantling and presorting strategies
- Automated shredding, sorting, and remelting
- Identifying the resulting compositions of recycled aircraft components
- Options for components in new aircraft
- Options for nonaircraft applications
- Options for aluminum castings

Components in aircraft

Table 1 illustrates composition examples from presorting of 2xxx and 7xxx alloys. Assuming that these estimated compositions are reasonably correct, it would appear that the resultant alloys could be suitable for a number of noncritical aircraft components, such as stiffeners, flaps, and other relatively low-to-moderately stressed components made of sheet, plate, or extrusions.

Typically, these would be components that are not designed based on fracture mechanics concepts such as fatigue crack growth rates and fracture toughness parameters. Alloys for fracture-critical areas may still have to be fabricated of primary metal. Further study is needed to estimate the percentage of aircraft components that do not require fracture-critical design, and whether it is broad enough to justify the reuse of compositions likely to result from recycling.

Non-aircraft applications

If these compositions for non-fracture-critical components in new aircraft are too tightly limited, non-aircraft applications may be possible, Table 2. To aid in addressing that question, the compositions of several wrought 2xxx and 7xxx alloys (including 2014, also an aircraft alloy) are presented in Table 3. Comparing compositions illustrates that it may be possible to recycle aircraft metal in certain other products. Further study of this option is justified.

Options for castings

Other opportunities may include aluminum alloy castings, especially those of the 2xx.0 and

Table 1 — Nominal compositions of some 2xxx and 7xxx alloys

Alloy	Al	Cu	Fe	Mg	Mn	Si	Zn
2014	~93	4.4	0.7 max	0.50	0.8	0.8	0.15 max
2214	~93	4.4	0.3 max	0.50	0.8	0.8	0.15 max
2024	~93	4.4	0.5 max	1.5	0.6	0.5 max	0.25 max
2324	~94	4.1	0.12 max	1.5	0.6	0.1 max	0.15 max
7050	~89	2.3	0.15 max	2.2	0.1 max	0.12 max	6.2
7075	~90	1.6	0.5 max	2.5	0.3 max	0.4 max	5.6
7475	~90	1.6	0.12 max	2.2	0.06 max	0.1 max	5.7
7178	~89	2.0	0.5 max	2.8	0.3 max	0.4 max	6.8

Table 2 — Some 2xxx and 7xxx alloys used in non-aerospace applications

Alloy	Application	Cu	Fe	Mg	Mn	Si	Zn
2014	Railroad; truck bodies	4.4	0.7 max	0.50	0.8	0.8	0.15max
2017	Rivets	4.0	0.7 max	0.60	0.7	0.5	0.25 max
7129	Auto bumpers	0.7	0.3 max	1.6	0.1 max	0.15 max	4.7

Table 3 — Potential compositions of some recycled aircraft alloys

Alloy	Al	Cu	Fe	Mg	Mn	Si	Zn	Other
(Presorted) R2xxx	~93	4.4	0.5	1.0	0.7	0.5	0.1	0.2
(Presorted) R7xxx	~90	2.0	0.4	2.5	0.2	0.2	6.0	0.2
(Not presorted) R2 + 7xxx	~92	3.0	0.4	1.8	0.4	0.4	3.0	—

Table 4 — Some aluminum casting compositions

Alloy	Al	Cu	Fe	Mg	Mn	Si	Zn	Other
201.0	~95	4.6	0.15 max	0.35	0.35	0.10	0.25	0.05 max
242.0	~94	4.1	0.6 max	1.4	0.10 max	0.6 max	0.10	0.05 max
295.0	~94	4.5	1.0 max	0.03	0.35 max	1.1	0.25	0.05 max
710.0	~93	0.5	0.5 max	0.7	0.05 max	0.15 max	6.5	0.05 max
713.0	~91	0.7	1.1 max	0.35	0.6 max	0.25	7.5	0.05 max

7xx.0 series, aluminum-copper and aluminum-zinc, respectively. Examples of such alloys are included in Table 4. Even these relatively tolerant limits present challenges for direct reuse of recycled metal. Nevertheless, opportunity for study of new alloy options remains, and the proper-

ties of the various aircraft alloys shown here should be evaluated for other applications. ◆

For more information: Subodh K. Das, Secat Inc., 1505 Bull Lea Road, Lexington, KY 40511; tel: 859/514-4955; skdas@secat.net; www.secat.net.

This article is from Chapter 9 of *Aluminum Recycling and Processing for Energy Conservation and Sustainability*, John H. Green, editor. For more information about this book, visit www.asminternational.org, and click on "ASM Store." It is under "New Releases." Or contact Customer Service at 800/336-5152, ext. 0.



Scratch More Than the Surface.

ASM International and the North American Die Casting Association present this intensive one-day workshop bringing together some of the world's foremost experts in the fields of dies, coatings, surface treatments, and failure mechanisms.

Surface Engineering for High Performance Die Casting Tooling, April 23, 2008 – conveniently located at the Hilton Garden Inn, Chicago O'Hare Airport.

The program will include three in-depth panel discussions on topics including:

- Heat Treatment
- Ion Nitriding
- Ion Implantation
- PVD & CVD
- Test Methods
- Application/Lessons Learned



Get practical information you can use.

- Reduce down time
- Reduce soldering
- Extend die life
- Increase productivity
- Reduce cost

Register today.

Advance registration closes April 7, 2008.

www.asminternational.org/diecasting2008

Book your hotel by calling **847.296.8900**.



North American Die Casting Association
www.diecasting.org



ASM International®
9639 Kinsman Road
Materials Park, Ohio 44073-0002
800.336.5152
www.asminternational.org