WEEKS DISTRIBUTORS DURAFIX ALUMINUM BRAZING

NO-BRUSH EXPERIMENT *2010/02/24 (http://www.durafix.com)*

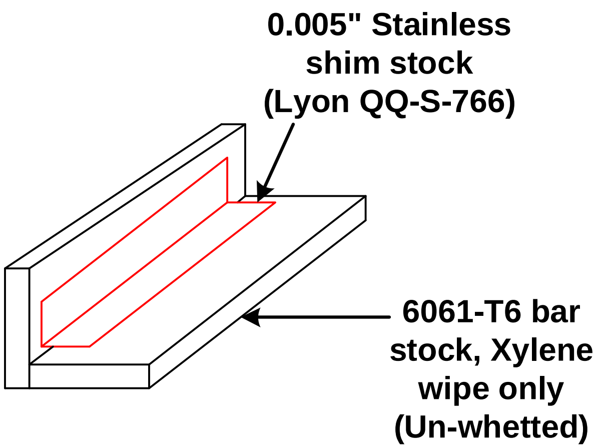
The theory is that it is the chromium from the stainless steel (SS) brush that is performing the fluxing function when brazing aluminum as opposed to mechanical preparation of the work piece surfaces. Since the chromium in SS is actually unbonded electrically to the other constituents in the alloy, this allows it to form a passivation layer over and protecting the underlying steel whenever new material is exposed. The passivation process in chromium is the same as it is for aluminum in that once formed, the oxide layer prevents oxygen from penetrating any further into the surface. In 302 stainless, chromium accounts for about 17% of the total alloy.

Chromium has oxidation states of +2, +3 and +6 vs aluminum with just +3. Oxygen has a single oxidation state of -2 hence the formula of aluminum oxide of Al_2O_3 (2x3 = 3x2). Chromium should therefore, under certain conditions, bond with twice as much oxygen per atom as aluminum and with it's higher electronegativity (1.66 vs 1.61) may even pull oxygen off the already formed aluminum oxide passivation layers on the work piece surfaces, forming a layer of mobile chromium oxide on top of now pure aluminum.

Based on this theory, the test was to take mechanically unprepared aluminum samples to be joined and use SS sheet to cover the joint to be brazed to assist in the brazing action by both forming a rarified oxygen environment due to the heating of the interfacial air and as a flux source of free chromium atoms evaporated off of the heated SS which would getter the free-floating oxygen and strip away oxygen from the alumina surface layer. Even when the SS is removed just prior to brazing, the residual chromium passivation layer which is loosely attached to the aluminum should prevent oxygen from attacking the now pure aluminum surface. A further test was to eliminate any mechanical raking of the aluminum surface with the brazing rod.

The picture of the cross section shows the result: I brazed a 3 inch length with good result with no mechanical preparation and by simply laying the rod across the joint once the aluminum had reached temperature and the SS overlay had been pushed away. The joint also shows excellent intermetallic alloying, i.e. the base material is dissolved into the filler material.

The next test is to do this in a vacuum and look at the surface resistance thermal weld characteristics of aluminum under the influence of chromium evaporated in proximity, i.e. single variable test.



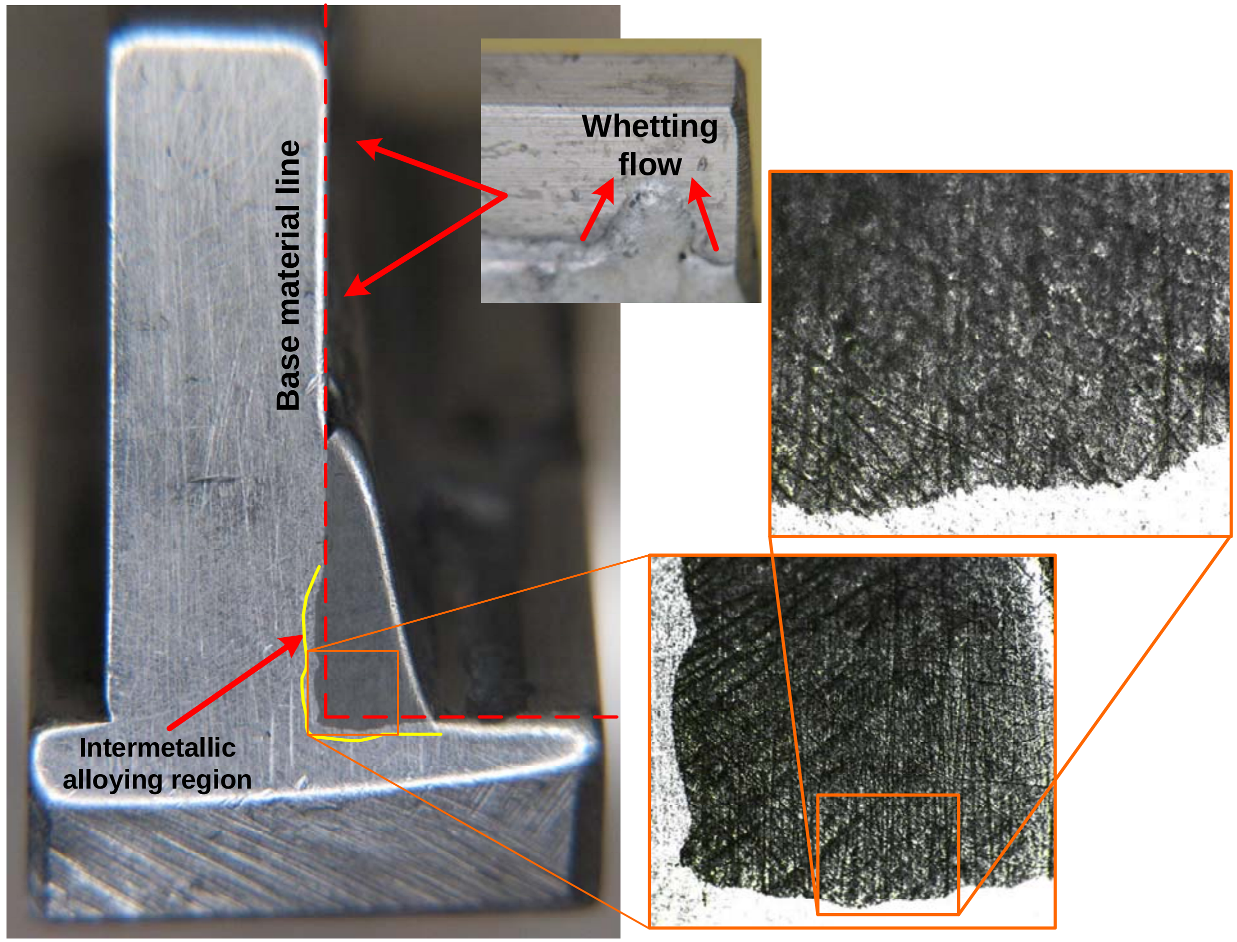
6061-T6 chemistry (%)

Al	Balance
Mg	0.800 - 1.200
Fe	0.700 max
Si	0.400 - 0.800
Zn	0.250 max
Cu	0.150 - 0.400
Ti	0.150 max
Mn	0.150 max
Else-total	0.150 max
Cr	0.040 - 0.350

302 SS chemistry (%)

Fe	Balance
Cr	17 - 19
Ni	8 - 10
Mn	2 max
Si	1 max
C	0.150 max
P	0.045 max
S	0.030 max

Chromium has an electronegativity of 1.66 vs aluminum at 1.61, indicating a higher electron attraction during chemical bonding than aluminum.



The aluminum was not brushed or mechanically prepared at all before setting into the vise, just degreased with Xylene. The SS shim was folded in half and set loosely at the inside corner of the joint until the base metal was at temperature, heated by a MAPP torch. Once at temperature, the SS was pushed out of the way with the DuraFix rod and the fillet flowed with no mechanical scrubbing action from the filler rod needed. The ease with which this joint was made without mechanical preparation and the depth of the intermetallic bond points to the chromium (or other element) from the stainless steel acting as the fluxing agent keeping the aluminum from forming an immiscible oxide layer.