Effects of Lubrication on Connector Processing

Abstract:

A class of lubricants described as "electrical conductive lubricants" are frequently encountered in the electronics industry and especially in conjunction with electrical connectors. These lubricants provide a number of benefits that include reducing the coefficient of friction, sealing plating pores, and reducing mate and un-mating forces.

Lubricants are applied post plating or post final connector assembly. When applied post plating, control depth or stream immersion techniques are commonly used. When lubricants are applied post assembly, brush techniques are typically employed. These techniques can allow for the "bleed over" of lubricants into areas where they are not needed, especially the lead or terminal region (portion of electrical conductor that terminates with the printed circuit board). Such "bleed over" or contamination becomes more problematic and prominent as the pitch and overall size of the metallic contact decreases. These lubricants are long chain polymers and it is conceivable that they could impair the processing of the connectors to the printed circuit board. They are made conductive through the addition of finely powdered metal held in suspension, or they can be displaced under the proper normal force and pressure conditions. These techniques and or properties prevent them from causing open circuits on the mating side of the connector.

This paper explores the effects of multiple variables on the successful processing of connectors contaminated with lubricant in the lead region. These variables are lubricant manufacturer, lubricant viscosity, processing technology, flux type and lead style.

Introduction:

This research was undertaken with the hypothesis that all flux types could remove all unwanted lubricant types from the leads. This shortened a traditional design of experiments to just examining worst case conditions. The variable extremes or worst case conditions were; least and most viscous lubricants, least and most aggressive fluxes, the greatest degree of contamination and finally, the optimal and most difficult to terminate lead styles. Controls for all test groups are included to identify processing error that may not be associated with lubricant contamination.

Lubricants may be used to reduce the significant forces needed to terminate compliant pin connectors. This effect will be discussed in this paper and was tested with these specimens because of its relativeness. The flip side of this benefit is that the retention force with the printed circuit may be reduced proportionately. This could be an issue for modern, high density compliant pin leads which already display exceptionally low retention force.

Test Plan:

A typical test matrix for a processing group is shown in Table 1. There were a total of four processing groups. The groups tested included standard product with no lubricant contamination (control) and the following groups contaminated with the named lubricant; Santolube OS-138, Miller Stevens MS-381HC, and Nye Uniflor 8917. The connectors tested were as follows; SEAM-50-02.0-L-10-2-A, ST4-50-1.00-L-P, HSEC8-150-01-L-DV-A, and TFM-140-01-L-D-A. The contaminated connectors were processed with leaded and lead free solder and no clean and water soluble fluxes. Leads were intentionally submerged and saturated with lubricant to create a worst case condition. Examples of the extent of the contamination may be seen in Figures 1 and 2. The white coating in Figure 1 is the Nye lubricant and covers nearly 100% of the regions to be soldered. A ultraviolet tracer is added to the lubricant shown in Figure 2. The purple regions are actual lubricant being illuminated by black light.

Fifteen connector assemblies were tested per run. The total number of leads tested and inspected varied as a function of position count, row count and the ability to visually inspect the lead. For example, on ST4, 50 leads per row, times 2 rows per connector, times 15 connectors per run were inspected. The total leads per run inspected was 1500. Conversely, for SEAM product only the outer leads could be inspected, 116 leads per connector, times 15 connectors, for a total of 1740 leads per run. All processing trials are summarized under IPG request CR63303 and CR82508.

RunOrder	Supplier/Lubricant	Comments	Connector System	Lead style	Processing Technology	*Flux Type-spec**	Evaluation Criteria
	Santolube OS-138	presently used by samtec					
		Au contact -20 to 350C				***Water soluble***	% wetting/overall solderability/wicking/bridging sufficent volume/UV tracer presence
1			SEAM	butt	Surface Mount Lead	HM531 (class III paste)	"
2			SEAM	butt	Surface Mount Lead Free	EM828 (class III paste)	"
3			TFM	thru hole	Wave Solder Leaded	Alpha 373 (flux)	"
4			TFM	thru hole	Wave Solder Lead Free	Alpha 373 (flux)	"
5			HSEC8	J	Surface Mount Lead	HM531 (class III paste)	"
6			HSEC8	J	Surface Mount Lead Free	EM828 (class III paste)	"
			ST4	butt no charge	Surface Mount Lead	HM531 (class III paste)	
			ST4	butt no charge	Surface Mount Lead Free	EM828 (class III paste)	
						no clean	"
7			SEAM	butt	Surface Mount Lead	Alpha OM-5100 (class III paste)	"
8			SEAM	butt	Surface Mount Lead Free	Alpha OM 338-T (class III paste)	"
9			TFM	thru hole	Wave Solder Leaded	Alpha NR 330 (flux)	"
10			TFM	thru hole	Wave Solder Lead Free	Alpha NR 330 (flux)	"
11			HSEC8	J	Surface Mount Lead	Alpha OM-5100 (class III paste)	"
12			HSEC8	J	Surface Mount Lead Free	Alpha OM 338-T (class III paste)	"
			ST4	butt no charge	Surface Mount Lead	Alpha OM-5100 (class III paste)	
			ST4	butt no charge	Surface Mount Lead Free	Alpha OM 338-T (class III paste)	
13			SEAMP	compliant	Press-fit without lube	NA	Termination/retention force

Table 1

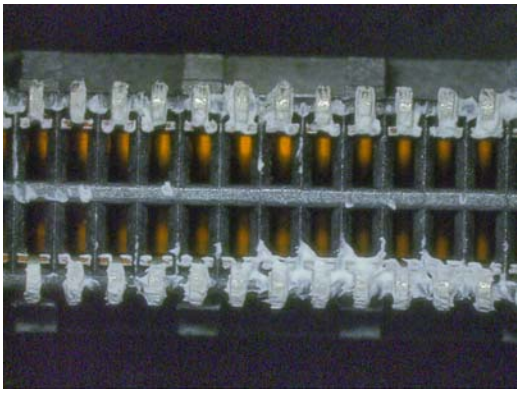

Figure 1 (Nye)

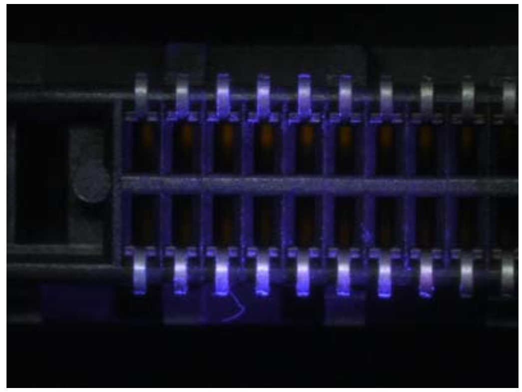

Figure 2 (Santolube)

The test plan for the compliant pin parts (SEAMP-50-02.0-L-10) can be found in Table 2

SEAMP-50-02.0-L-10 control		**SEAMP-50-02.0-L-10 OS-138 Lubricant**		**SEAMP-50-02.0-L-10 MS-381 Lubricant**		**SEAMP-50-02.0-L-10 NY8917 Lubricant**	
TEST GROUP 1		TEST GROUP 2		TEST GROUP 3		TEST GROUP 3	
STEP	10 connectors	STEP	10 connectors	STEP	10 connectors	STEP	10 connectors
1	PTH Diameter	1	PTH Diameter	1	PTH Diameter	1	PTH Diameter
2	Lubricant presence	2	Lubricant presence	2	Lubricant presence	2	Lubricant presence
3	Terminate	3	Terminate	3	Terminate	3	Terminate
4	Pull test	4	Pull test	4	Pull test	4	Pull test

Table 2

Results Summary:

The SEAM connectors processed successfully meeting IPC-A-610F standards with no solder joint quality issues for all lubricants (see Figure 3). Removal of remnant NYE 8917 lubricant post processing proved slightly problematic for a no clean flux (see figure 4). No such condition was observed with other lubricants or fluxes.

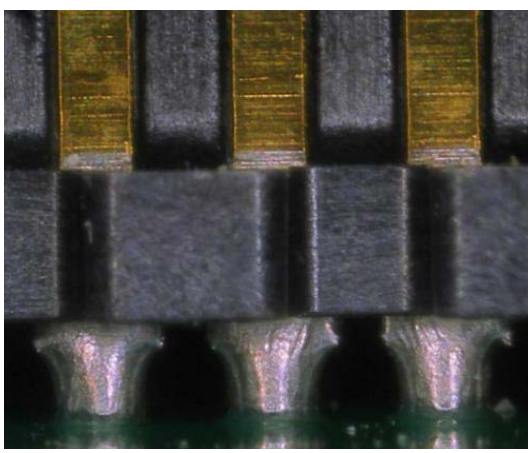

Figure 3

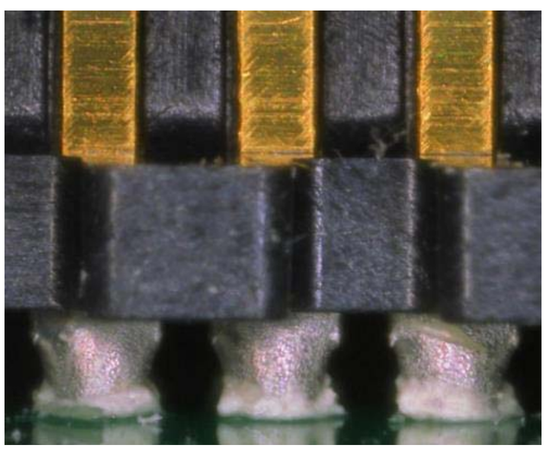

Figure 4

The ST4 connectors processed successfully meeting IPC-A-610F standards with no solder joint quality issues for the OS-138 and MS 381 lubricants (see Figure 5). Some of the connectors processed with the Nye lubricant failed to wet properly (see figure 6). Removal of remnant NYE 8917 lubricant post processing proved problematic for a no clean flux (see figure 7). No such condition was observed with other lubricants or fluxes.

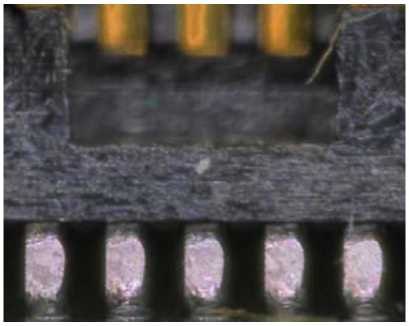

Figure 5

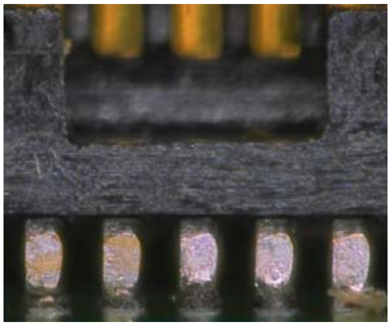

Figure 6

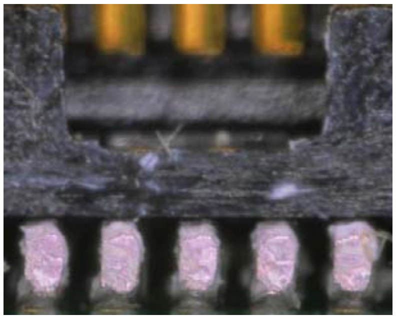

Figure 7

The HSEC8 connectors processed successfully meeting IPC-A-610F standards with no solder joint quality issues (see Figure 8). Removal of remnant NYE 8917 lubricant post processing proved problematic for a no clean flux (see figure 9). No such condition was observed with other lubricants or fluxes.

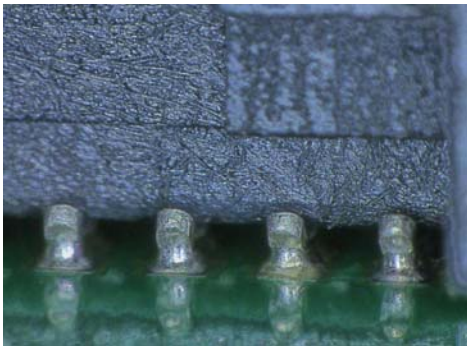

Figure 8

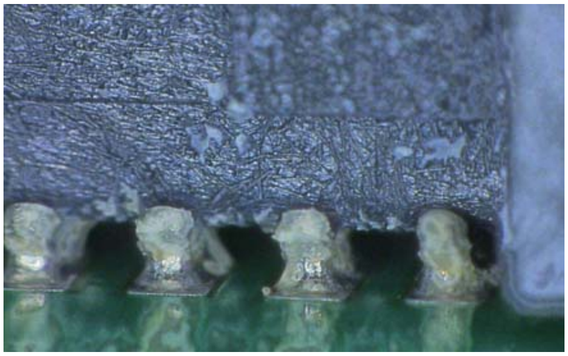

Figure 9

Testing of TFM connectors proved inconclusive for all variables. Insufficient barrel fill according to IPC-A-610F classes 1, 2 and 3 occurred on all samples including those in the control group (see figure 10). A variable other than those examined here is responsible for this outcome.

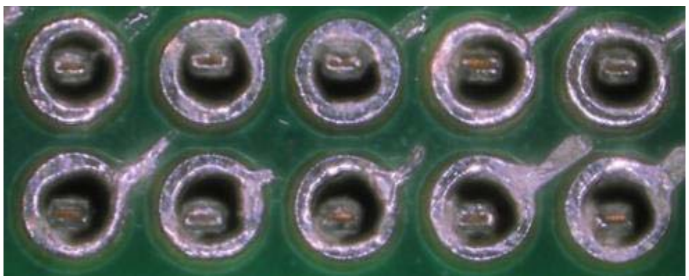

Figure 10

The use of lubricants dramatically lowered the total termination load for all compliant pin parts (see Table 3). The test setup can be seen in Figure 11. Unfortunately, an accurate measurement of an extraction force proved impossible due to the product and printed circuit board design.

		IR 891874		
	GROUP #1	GROUP #2	GROUP #3	GROUP #4
	Standard Product	SEAMP-50-10-OS138	SEAMP-50-10-MS381	SEAMP-50-10-NY8917
Min.	1795.00	1175.00	1109.00	934.60
Max.	1942.00	1607.00	1783.00	1872.50
Ave.	**1861.75**	**1355.88**	**1370.03**	**1270.66**
	% Reduction	**27.2%**	**26.4%**	**31.7%**

Table 3

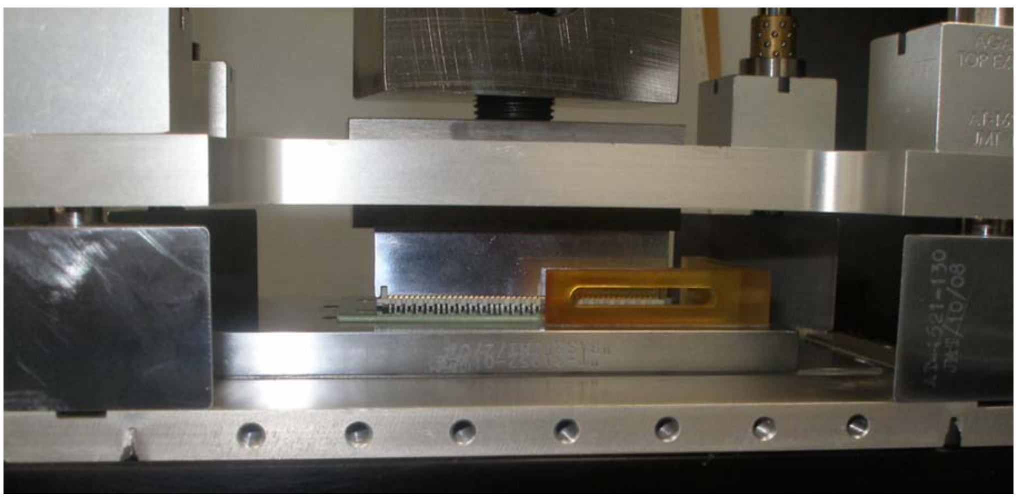

Figure 11

Conclusion:

The objective of this test was to determine if any level of connector lubricant contamination in the lead region of the connector could result in processing defects. The effects of lubricant type, lead geometry, flux type, and processing technology were considered as variable in this study.

Based on the testing summarized here, it is highly unlikely that the Santolube OS-138 used by Samtec will ever result in any processing problems for any level of accidental lead contamination.

The probability of a processing problem for typical accidental lead contamination with any connector lubricant, any process, lead style and flux is believed to be very low. Wetting issues were observed on 0.40mm pitch connectors only. Removal of remnant Nye lubricant was only problematic for no clean fluxes. These issues seem minor given the degree to which the terminals were contaminated with lubricant.

References:

CR 63303 IPG processing trial HSEC8
CR 82508 IPG processing trial SEAM, TFM, and ST4
IR891874 ESG testing SEAMP