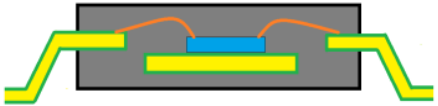
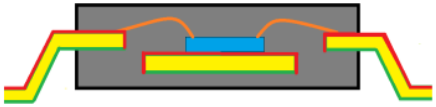
Roughened Leadframes

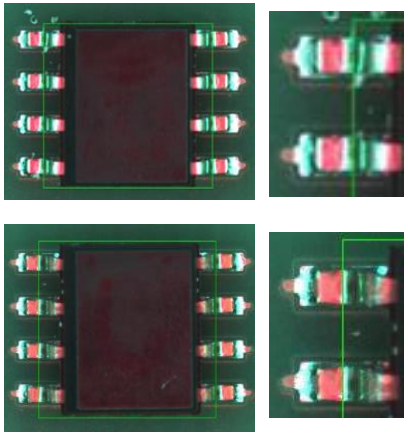
Package Mechanical Integrity Improvement Strategy

Roughened Leadframes

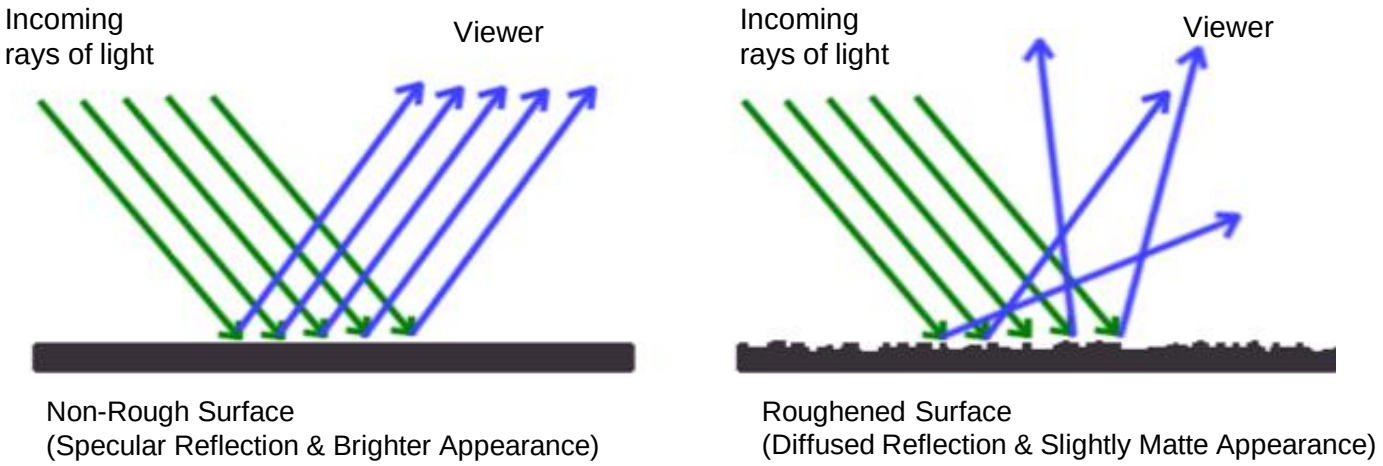
- Texas Instruments has introduced Rough Leadframe Technology to enhance the mechanical stability of the package.
- This technology in know also know as “Single Side Rough”, as can be seen in the diagram below.
- The non-Rough and Rough versions are identical in material content, differing only slightly in appearance due to the Rough’s increased diffused light reflection.

Non-Rough Pre-plated Leadframe **Base Cu** **non-rough NiPdAu finish**	
Single Side Rough Pre-plated Leadframe **Base Cu** **non-rough NiPdAu finish** **Rough NiPdAu finish**	

AOI Tool View



Single Side Rough Appearance

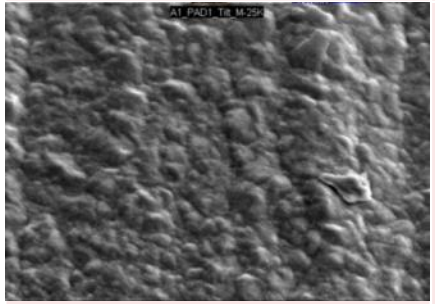
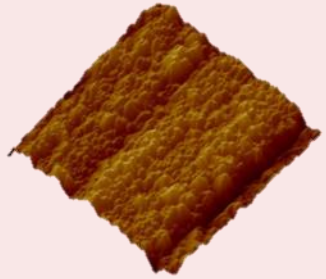
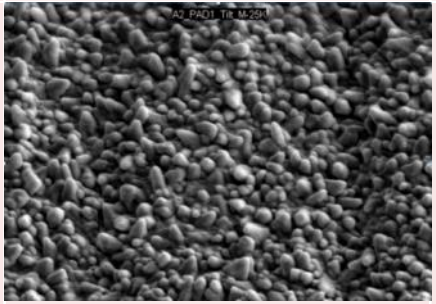
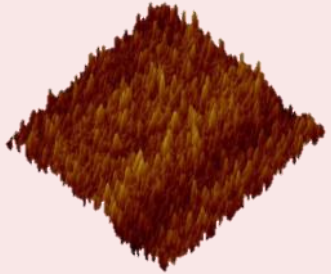


Non-Rough Surface
(Specular Reflection & Brighter Appearance)

Roughened Surface
(Diffused Reflection & Slightly Matte Appearance)

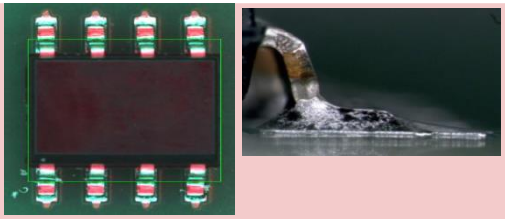
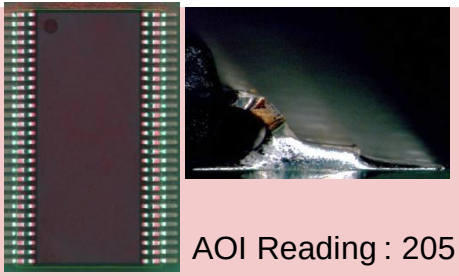
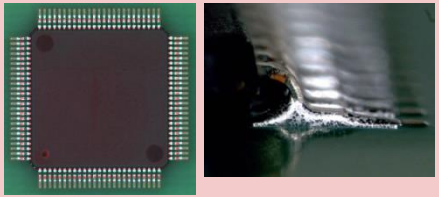
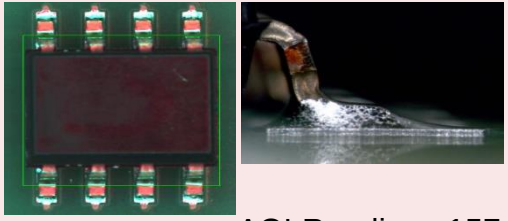
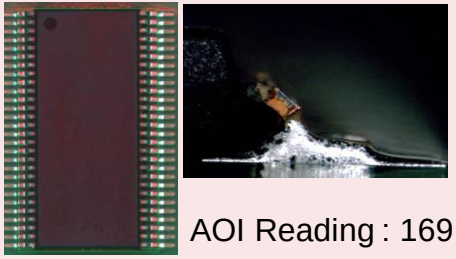
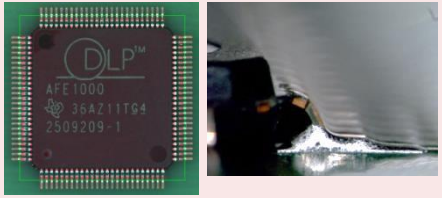
- The Non-Rough Leadframe's relatively smooth surface has a brighter appearance due to the predominant specular reflection.
- The Rough Leadframe's textured surface has a slightly matte appearance due to the increased amount of diffused refection.

Non-Rough vs Rough Leadframe Surface

Non Roughen Leadframe		Roughen Leadframe	
SEM @25Kx	AFM	SEM @25Kx	AFM
			

- Roughening significantly increases the amount of contact area between the Leadframe surface and the package mold material, enhancing the interfacial strength.
- The Roughening is created during the Leadframe manufacturing process by roughening the underlying metal.
- The pre-plated finish on Non-Rough and Rough Leadframes are identical NiPdAu.
- ZVEI change matrix ID # SEM-PA-04 guidance addresses changes of the internal lead frame finish material. The Single Side Rough finish material's composition is not changed.

Automatic Optical Inspection (AOI)

Package	SOIC	TSSOP	QFP
Non-Rough Leadframe	 AOI Reading : 182	 AOI Reading : 205	 AOI Reading : 211
Roughen Leadframe	 AOI Reading : 157	 AOI Reading : 169	 AOI Reading : 173

AOI scale is from 0~255

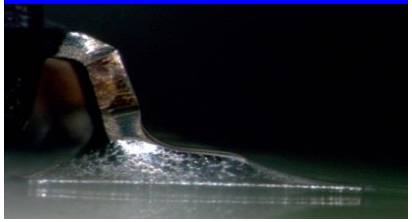
- The Rough Leadframe's diffused light reflection is confirmed by the AOI lower brightness reading.
- Actual readings will vary dependent on the AOI tool and light settings.

SMT Soldering Assessments

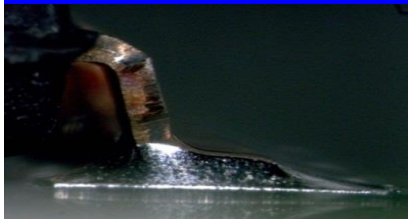
- No changes are required in either the PCB level assembly process flow or equipment settings for the Rough Leadframe.

Solder wicking comparison

non -Rough LF



Rough LF

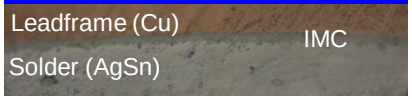


- No difference in solder wicking between non-rough and rough
- Meets IPC-A-610-E and JEDEC 22-B102E criteria

IMC comparison

Initial as soldered

non -Rough LF



Rough LF

Post 500 Temp Cycle

non -Rough LF

Rough LF

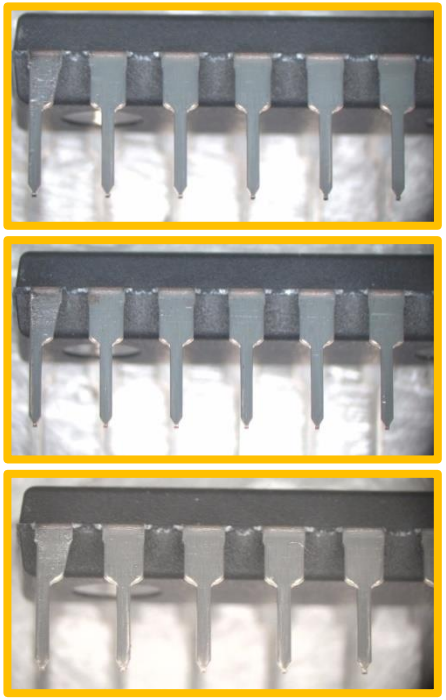
- No difference in IMC formation between non-rough and rough
- No change to solder joint reliability

‘Lead Discoloration’ Assessments

1. Roughen lead appearance often misunderstood with lead discoloration, solder issue, no plating, abnormal LF, Oxidation, insufficient lead finished, plating issue, etc
2. ‘*Lead discoloration’* is assessed with simulations followed by stress (for solder only).
3. Simulations:
   a) Bare hand touch deposits sweat and grease on the leadframes.
   b) Finger coat touch to observe any abrasion on the lead surface with finger coat
   c) Sand paper scratch to simulate mechanical contacts (worst case) by machines on the leads.
4. Stress test to simulate LF condition after 5 years.
   a) Preconditioning followed by HTSL at 170C for 572 hours
   b) Preconditioning followed by AC 121C for 176 hours
5. Sample pictures shown in simulations are **time zero** (after assembly), **post stress** and **solderability results**.

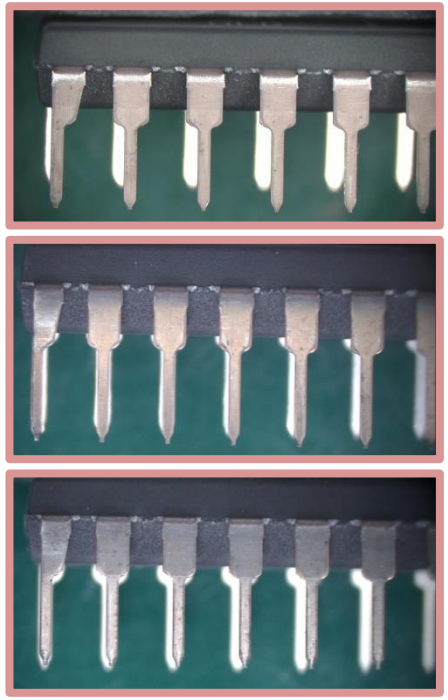
Control: No Contact

Time zero units



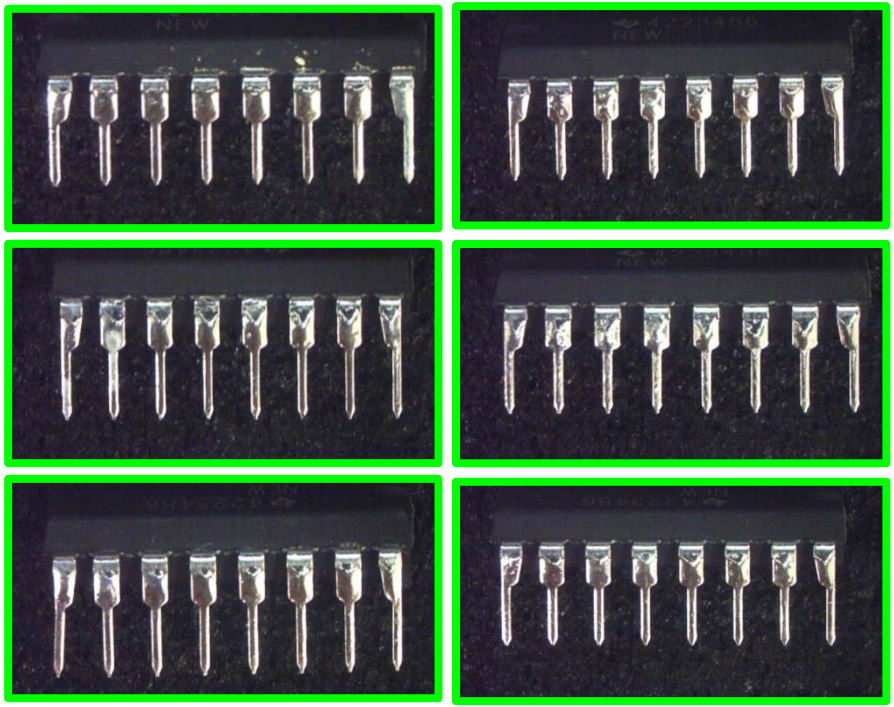
Clean Leads

Post Stress Units



Leads changed color to darker or brownish

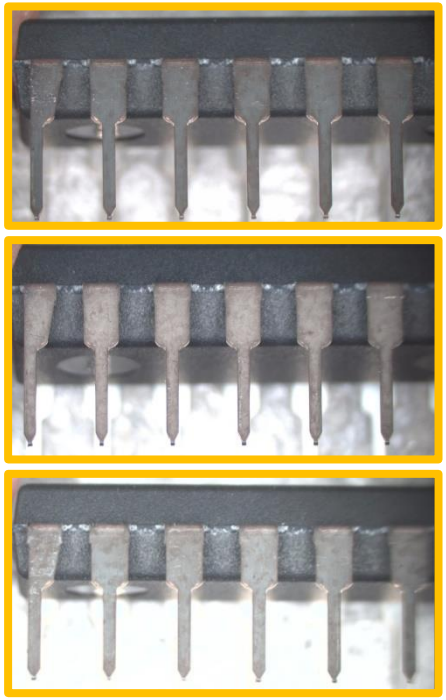
Solderability



Solderability is passing after HTSL and AC

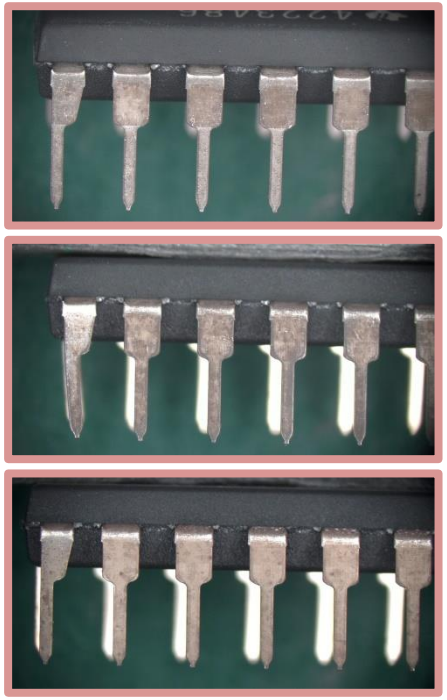
Simulation 1: Bare hand touch

Time zero units



Sweaty bare hand touch on LF leaves black spots on leads

Post Stress Units

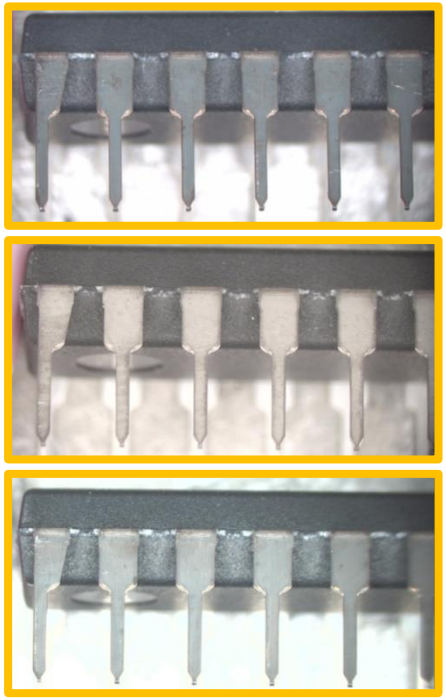
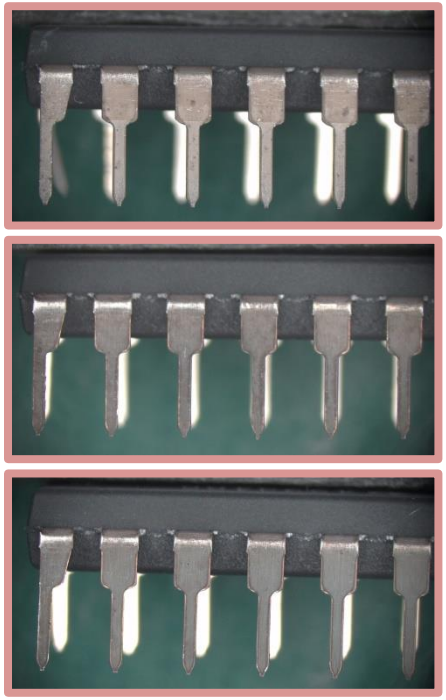
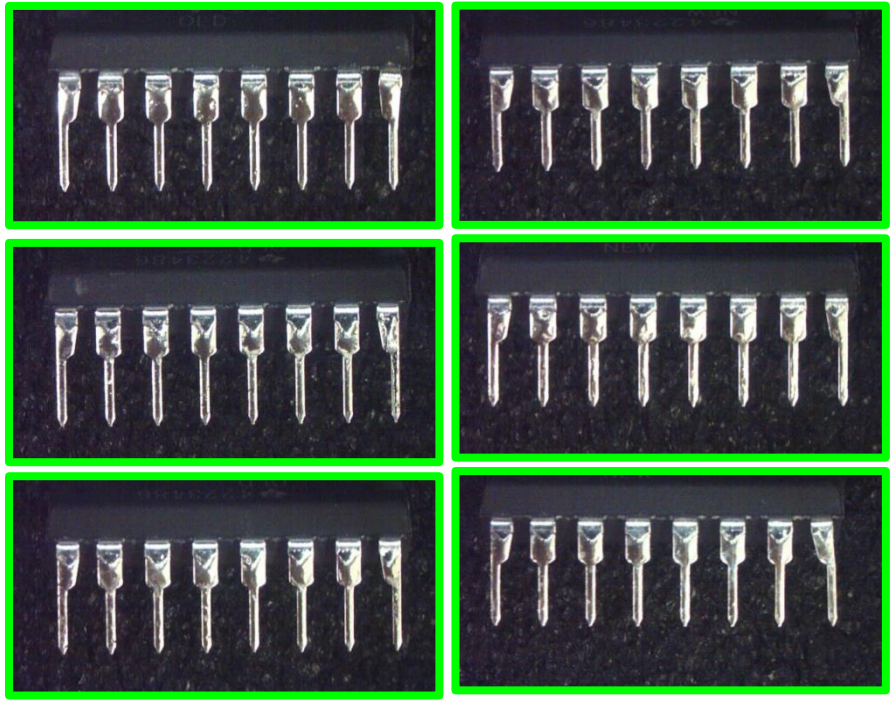


Black spots are darker after stress.

Solderability

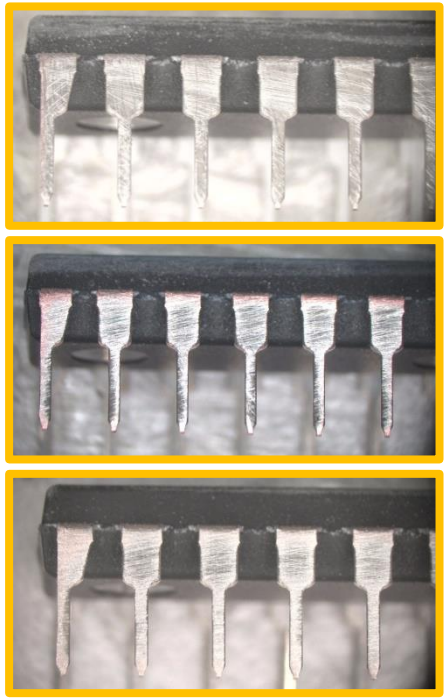
Solderability is passing after HTSL and AC

Simulation 2: Finger Coat Touch

Time zero units	Post Stress Units	Solderability
		
Mild spots observed	Mild spots are darker and visible after stress.	Solderability is passing after HTSL and AC

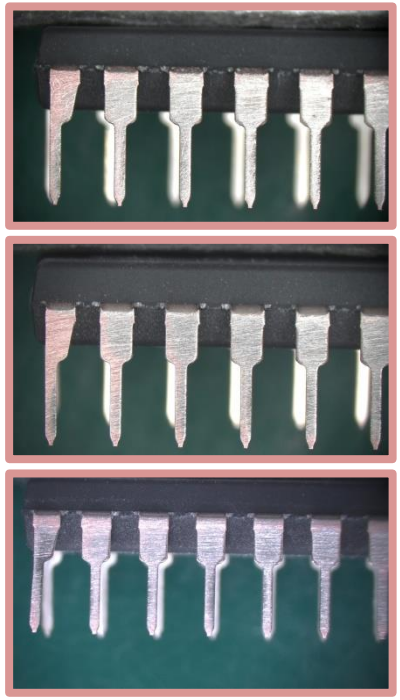
Simulation 3: Sand paper scratch

Time zero units



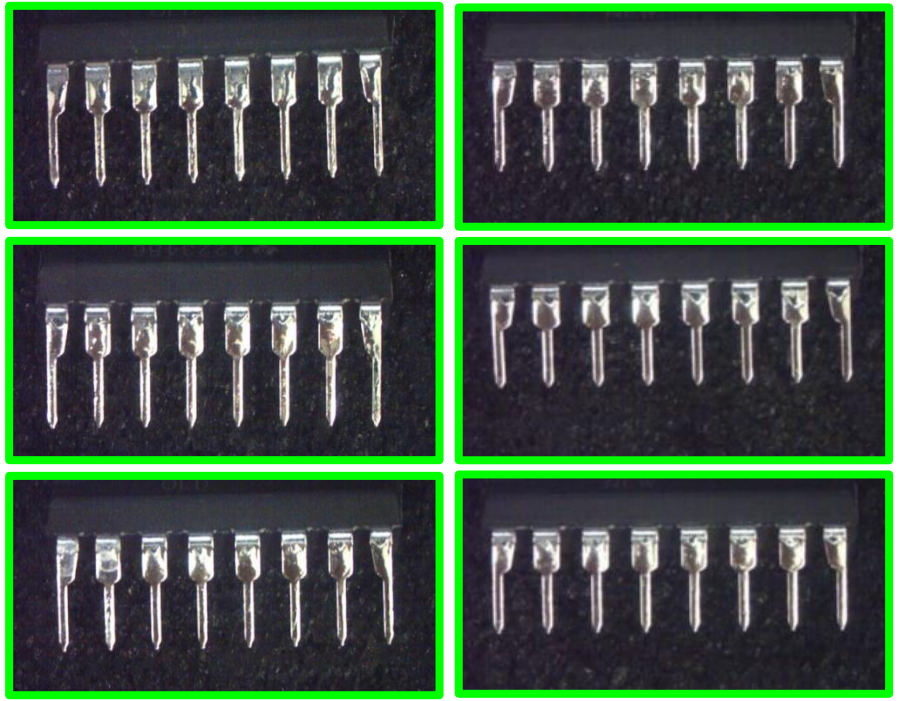
Gross scratches by sand paper

Post Stress Units



Heavy scratches changed to brownish color

Solderability



Solderability is passing after HTSL and AC

‘Lead Discoloration’ Assessment Summary

1. All simulations are **passing** solderability,
2. Control units’ leads changed appearance to darker shade or brownish after stress correlates with darker lead observation and high vision failure from long staging lots.
3. Bare hand touch deposits sweat and grease that observed as black spots on the leads. These spots turned darker after stress.
4. Similarly, finger coat touch has darker spots after stress.
5. Sand paper scratches are gross: worst case scenario (though, never seen scratches like this). The scratches are removed the roughen surface. This can be correlated to brighter spots on the leads that resulted from mechanical machines contacts like mold clamp, and forming tool.