Tensile Test Sample Preparation Techniques for Hot Dip Galvanized, Light Gauge Steel

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Tensile testing specifications (ISO, ASTM, DIN, JIS) are well established for defining the geometry of specimens and the conditions for conducting the tensile test; however, sample preparation is a topic that is not well defined in published standards. There are numerous techniques for creating tensile bars, including die cutting, machining, electric discharge machining (EDM), grinding with abrasive paper, and using a specially designed instrument such as a TensilkutTM. In all cases, the goal is to create a sample that represents the true properties of the material.

An issue that has continued to be the subject of debate based on varying sample preparation techniques, which have led to inconsistent results, is the preparation of thin (<0.25 mm, or 0.01 in.), coated steel tensile test specimens. The coating most often encountered on this type of steel is hot-dipped galvanized (HDG) zinc. While other coated steel, including tin-plate and aluminized, also create sample preparation difficulties, the focus here will be on galvanized steel.

Sample preparation of light gauge (thin) steel requires substantial effort in order to avoid deforming the specimen while simultaneously creating an edge that is free of cracks, tool marks, heat distortion, and edge burrs. Typically, die cutting test specimens creates an unacceptable edge on light gauge steel, as substantial deformation is created. Many machining operations also result in specimens with tool marks on the edge and large burrs present.

The edges of thin steel specimens are often finished by hand (a process referred to as dressing the edge) using a fine file, abrasive stone, or abrasive grit paper. While this will remove tool marks and burrs, dressing the edges is not without problems. The technique used to finish the edge may vary from person to person and in the case of light gauge steel, rounding of the edges may cause a change in the geometry of the specimen that is not insignificant. A sample preparation technique that results in defect-free edges with no post preparation dressing would be ideal. To the best of the author's knowledge, no technique has been proven effective for this to date.

The other issue with HDG light gauge steel is whether or not to remove (strip) the Zn from the specimen. The author's laboratory often sends samples to external labs as a check to ensure that the results we generate in-house are consistent with others. There is broad disagreement on whether or not to remove the Zn, which is typically done by immersing the entire sample in a hydrochloric acid solution. Several labs always remove the Zn, while others

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never remove the Zn because they feel that this introduces more potential defects in the sample. Another laboratory only strips the Zn if the hardness of the steel is less than 30 on the Rockwell C scale.

Typically the mechanical properties measured are within the confidence limits both when the Zn is removed and when it is left in place. When results come back that are outside the confidence limits for a particular sample set, the debate cannot be easily settled, as the difference in sample preparation cannot be ruled out as a root cause for the outlying values.

This leaves open the question as to what is the best tensile test sample preparation method for HDG light gauge steel. We would like to hear from the readers of *Metallography, Microstructure, and Analysis* on this topic. If your laboratory works with HDG light gauge steel or other coated steels that are difficult to prepare for tensile testing, please take a moment to look at the brief set of questions below and respond directly to the author with your best practices. It is the intention of the author to collect responses, and report the results back in an issue of the journal later this year. All responses will be kept confidential, and it is our hope that the follow-up to this article will provide some guidance on best practices for preparing HDG light gauge steel tensile test specimens.

Survey Questions

- Please send responses to Elvin.Beach@worthingtonindustries.com.
- 1. What method is used at your facility for cutting tensile test specimens from light gauge steel (<0.25 mm or 0.01 in. thickness)? (Please provide as much detail as possible including type of tooling, or die, load, speed, etc.)
- 2. Is lubricant used when milling, machining, or cutting tensile test specimens? If yes, what type?
- 3. Is the Zn coating removed from test specimens? If yes, is the Zn removed before making tensile test specimens or after, and what is the method used for removing the Zn?
- 4. Are the edges of tensile test specimens inspected with an optical microscope after preparation?
- 5. Are the edges of light gauge steel tensile test specimens finished or “dressed” after the dog bone is cut out? If yes, what materials and techniques are used to do this?
- 6. Are there any specific techniques used that are not standard machining and finishing practice that have been particularly successful for your HDG light gauge steel tensile sample preparation?