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AMERICAN GEAR MANUFACTURERS ASSOCIATION

Shot Peening of Gears

AGMA 938-A05

AGMA INFORMATION SHEET

(This Information Sheet is NOT an AGMA Standard)

American Gear Manufacturers Association

Shot Peening of Gears
AGMA 938–A05

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ABSTRACT

This information sheet provides a tool for gear designers interested in the residual compressive stress properties produced by shot peening and its relationship to gearing. It also discusses shot media materials, delivery methods, and process controls.

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of AGMA Information Sheet 938–A05, *Shot Peening of Gears*.]

The purpose of this information sheet is to provide a centralized reference for shot peening information for other AGMA documents. Previously, multiple AGMA documents had varying descriptions of the shot peening process. This information sheet provides a thorough process description to assist the gear designer in understanding and implementing the shot peening process.

The first draft of AGMA 938–A05 was made in August 2003. It was approved by the AGMA Technical Division Executive Committee in May 2005.

Suggestions for improvement of this document will be welcome. They should be sent to the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314.

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American Gear Manufacturers Association –

Shot Peening of Gears

1 Scope

The purpose of this document is to provide an informational tool for gear designers interested in the residual compressive stress properties produced by shot peening and its relationship to gearing.

Information on shot peening and residual stress is subject to some interpretation; therefore, this document is classified as an information sheet and not a standard. This document intentionally avoids any reference to quantifying potential increases in gear ratings through the use of shot peening. Any ratings increase attributed to shot peening should be agreed upon between the gear manufacturer and purchaser, and preferably verified through testing.

This document is intended for use by those experienced in gear materials and design. It is not intended for use by the engineering public at large.

Annex A provides figures and tables in U.S. customary units.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this information sheet. At the time of publication, the editions were valid. All publications are subject to revision, and the users of this information sheet are encouraged to investigate the possibility of applying the most recent editions of the publications listed.

ANSI/AGMA 1012-G05, *Gear Nomenclature, Definitions of Terms with Symbols*.

AMS-S-13165, *Shot Peening of Metal Parts* (formerly MIL-S-13165).

3 Theory of shot peening

The primary purpose for shot peening is to induce beneficial residual compressive stresses in the subsurface layer of a part. This occurs by bombarding a metal's surface with small, round particles called shot. Each impact of the shot media has the effect of leaving a small hemisphere of residual compressive stress that occurs from localized yielding of the base material at the point of shot impact. The material's surface attempts to restore itself, but is restrained by adjacent material, resulting in a residual compressive stress. Through repeated impacts that create overlapping dimples, a uniform layer of residual compressive stress can be expected, provided the shot peening process and media are carefully controlled.

During service, a gear root fillet is subject to repeated bending loads. These loads generate applied tensile stresses which are highest in the material's subsurface layer. With the addition of shot peening, applied bending stresses are opposed by residual compressive stresses that have the effect of resisting fatigue crack initiation and growth throughout the compressive layer. For bending fatigue improvement, shot peening should extend, as a minimum, from the bottom of the root fillet past the tangent point between the root and flank.

The beneficial characteristics of residual compressive surface stresses are associated with their effects on fatigue crack initiation behavior. Net stress is the summation of applied and residual stress. When the magnitude of the residual compressive stress is greater than the magnitude of the applied tensile stress, a net compressive stress is created. In theory, fatigue cracks will not initiate in a net compressive stress zone. In addition, fatigue cracks do not propagate as readily in a compressive stress zone.

Residual compressive surface stresses are effective in improving bending fatigue life in the elastic material behavior (high cycle fatigue) regime. Loading in the plastic material behavior (low cycle) regime eliminates life improvement effects of residual compressive stresses. Failures in the elastic material regime generally initiate at the surface, making surface compressive stresses effective.