ULTRASONIC INSPECTION POTENTIAL FOR POLYMERIC COATINGS

M. S. Good*, J. B. Nestleroth † and J. L. Rose †

*Ultrasonics International, Incorporated
Trevose, PA 19047
†Drexel University
Philadelphia, PA 19104

The nondestructive measurement of adhesion quality in a coating process is critical to insure the integrity of the polymer surface. One effective means of evaluating this bonding mechanism is via the implementation on nondestructive ultrasonic techniques. Extensive work has already been successfully applied to the general use of ultrasonics to predict adhesive bond quality1-8. Much of the technology can be transferred over to measure adhesion quality between the thin coating and the substrate surface. Thin coatings, characteristic of approximately a five micron cross sectional thickness, are usually considered far beyond current state-of-the-art techniques due to axial resolution limitations. Proper adaptations of current testing methods and use of frequency features, however, have been demonstrated useful. An ultrasonic Feature Scan9, F-Scan, is provided which clearly distinguishes substrate surface areas having coating adhesion from those areas not having coating adhesion.

The extremely small cross sectional thickness of the polymeric coating imposes a difficult inspection problem. Basic physics was utilized to select special transducers and to assist data analysis for selection of meaningful parameters indicative of adhesive integrity. Careful analysis of specimen geometry and selection of probe frequency characteristics allowed excellent results to be obtained. Adhesion quality was determined by measuring the shifting of a spectral depression resulting from a destructive interference phenomenon10.
A F-Scan was performed by selecting a threshold value whereby a spectral depression shift to one side of the threshold value determined the presence of adhesion while occurrence of the spectral depression to the other side of the threshold value indicated the lack of adhesion.

This research effort demonstrates the feasibility of implementing ultrasonics as an instrument for evaluating polymeric coating integrity. Along with the methodology used for detecting coating adhesion, a review of basic ultrasonic scanning procedures are included for reference purposes. These techniques that are commonly used for adhesion bonding should be transferable or adaptable to the special case of thin polymeric coatings.

INTRODUCTION

The coalescence of a useful ultrasonic inspection system requires a thorough knowledge of how the waveforms are generated, the behavior of the waves in the selected propagating media, the directivity of the sonic beam, constructive and destructive interference phenomena, etc. and how these specifically apply to the special application of thin coatings. For completeness, let us now review some basic physical principles and scanning techniques applicable to ultrasonic adhesion bond inspection and then focus on the specific case of thin coatings.

BASIC PRINCIPLES

The basic heart of the ultrasonic system is the transducer being used. A proper transducer selection includes such considerations as the scanning technique to be implemented, axial and lateral resolution characteristics of the transducer, frequency characteristics of the initiated sonic wave, layered structure of propagating medium, etc.

Most transducers function via a piezoelectric crystal which by definition transforms electrical energy into mechanical energy and vice versa. Transducer characteristics result from the effective shape, extent, and the acoustic impedance of the piezoelectric crystal along with the electrical impedance of the transducer. Many of these parameters are interrelated and are furthermore restricted by current manufacturing technology. In selecting any transducer, a set of priorities must be established as to what characteristics are more critical and to what degree can one