Examination of the Probe-Knot Junction to Estimate Duration of Electronic Control Device (TASER) Exposures

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ABSTRACT

Beginning in 1999, Electronic Control Devices (ECD) or TASERs have become standard less-lethal devices for many law enforcement agencies across the US. Their intended purpose is to deliver an incapacitating shock to a subject through two wire tethered probes. When "post use" analysis is required of the forensic scientist, standard tools of the trade can be employed to assist in the investigation. Microscopic physical characteristics of the probe/knot junction can determine if the TASER application was successful in transferring electrical energy to the subject. While comparing fifty samples using both stereomicroscopy and Scanning Electron Microscope (SEM), we were able to determine if a patent circuit was completed during the deployment. In some instances application duration could be determined.

Introduction

When a TASER device is activated, current across a small primer in the TASER cartridge ignites it, forcing a nitrogen capsule rearward into a hollow puncture pin. The compressed nitrogen is released into two chambers forcing the blast doors, probes, probe wires, and Anti-Felon Identification tags (AFIDs) forward out of the cartridge. The two aluminum/brass probes attached to thin insulated wires impact into a target. If the probes are typically within two inches of a conductive target, electrical energy will be transferred between the two probes completing the electrical circuit. The completed circuit delivers TASER pulses (electrical energy, typically 5 seconds) through the target in an attempt to temporarily incapacitate the subject(1).

For energy to be transferred from the TASER device, both probes must simultaneously contact the subject to complete the electrical circuit. When this occurs, electrical energy flows through the wires to the probes and though the subject. The probes can miss the target, become dislodged during the incident, or can come to rest greater than two inches from a conductive surface. If this occurs, the electrical energy will complete its circuit across the wires or by arcing in front of the electrodes of the TASER device and energy will not be delivered into the target. Determining which of these occurred is crucial to reconstructing a TASER incident.

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Methodology

Historically, the main tool for the investigator has been the data available from the TASER unit itself. The TASER X26 has "on-board" memory that records the activation time and duration of the firing. This data, however, does not necessarily equate to the duration of electric energy received by the subject through the probes.

The wire from the TASER cartridge is connected to the probe by a single knot tied at the base of the probe. At the probe-knot junction, the electric spark arcs between the end of the wire knot and the probe (air-gap) completing the circuit (Figure 1). Due to the impedance of the air-gap, this arc creates heat resulting in melting, scoring, and carbon residue deposits on the knot and the inner surface of the TASER probe from the thermal insult. The presence of these morphological changes indicates a completion of an electrical circuit needed for the desired TASER effect. When no changes on the end of the knot are observed, it can be concluded that the subject likely received little or no electrical energy from the device.

Sample Examination and Results

Twenty-five TASER cartridges (fifty probes) were fired into conductive media at 1, 5, 10, 20, and 30 second durations (Figure 2). The probes from these cartridges were examined stereo microscopically and with the Scanning Electron Microscope (SEM). The physical changes (carbon residue, melting, scoring, and pitting) on the wire knots and the inner probe surface were measured and quantified. It was

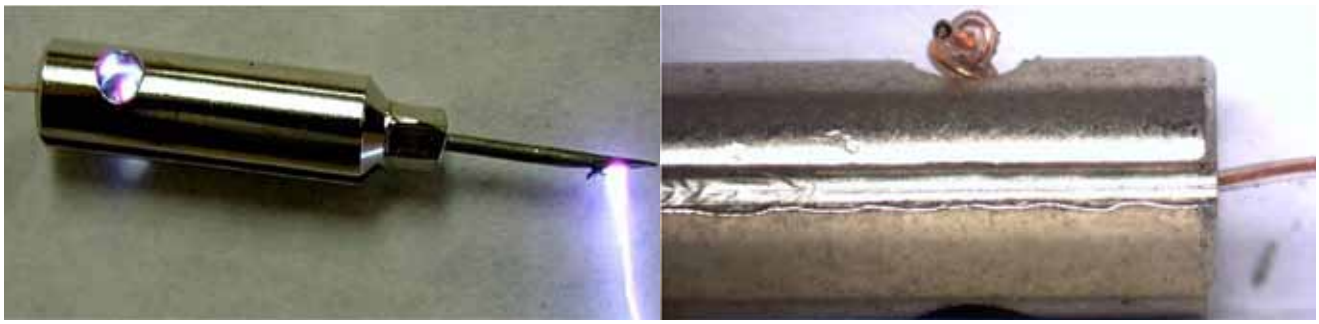

Figure 1: Probe/Knot Junction

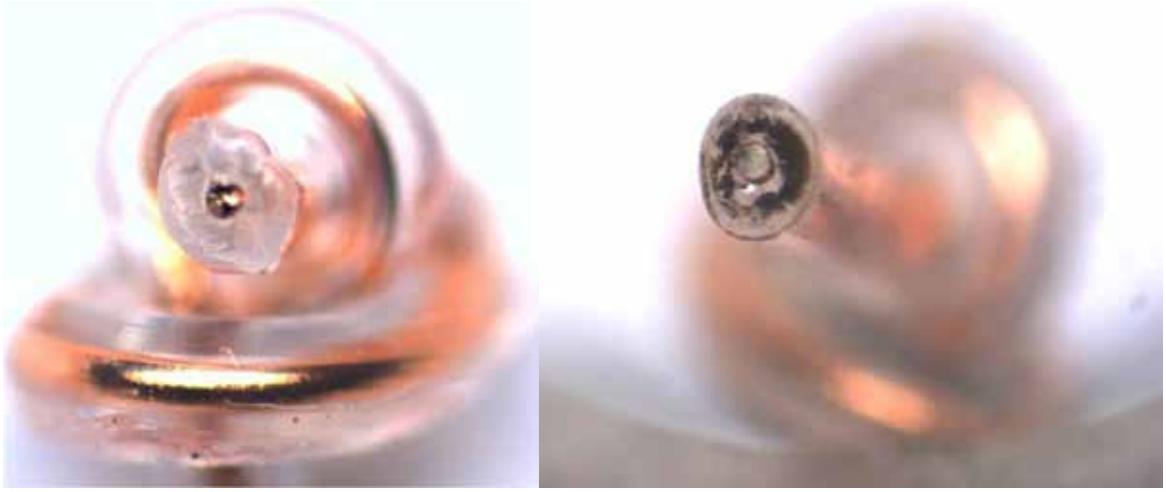

Figure 2: Short Duration (Left) Long Duration (Right)

determined that analysis of the physical changes and residue left on the probes and wire knots can be informative. This information can indicate the completion of the circuit between the probes; electrical energy delivered to the subject.

By using stereo and electron microscopy to document, measure and quantify the physical changes of the TASER probe/wire junction, data on the amount of electrical energy delivered to the subject be estimated over a wide range, but cannot be conclusively determined within the 1, 5, 10, 20, 30 second time frames. If the evidence is properly collected and documented, qualities present on the probes can be compared to the data recorded in the TASER unit itself to help approximate duration of electric energy the subject received during the incident (Figures 3 & 4).

Limitations on Conclusions

When the ends of the wire and insulation and the probe/knot junction are subjected to electrical energy from the TASER cycle, morphological changes are clearly observed. Analysis of the probe/knot junction can be invaluable in the investigation of a TASER incident. Due to the inherent variability of the knot tail lengths and impedance differences in the human body, precise durations of the circuit could not be accurately determined. Differences within multiple TASER cycles may be categorized based on morphological changes but are not scientifically conclusive. Most conclusions should be limited to a "Hit" vs. "miss" except in cases where there it is an extreme duration such as 30 seconds or more.

Future Study

TASER International has redesigned their probes with the new X3 model eliminating the probe/knot junction. The wire is now crimped along the length of the probe terminating near the needle base (Figure 5a & 5b). We currently have a study underway evaluating efficacy of duration estimation of these new probes.

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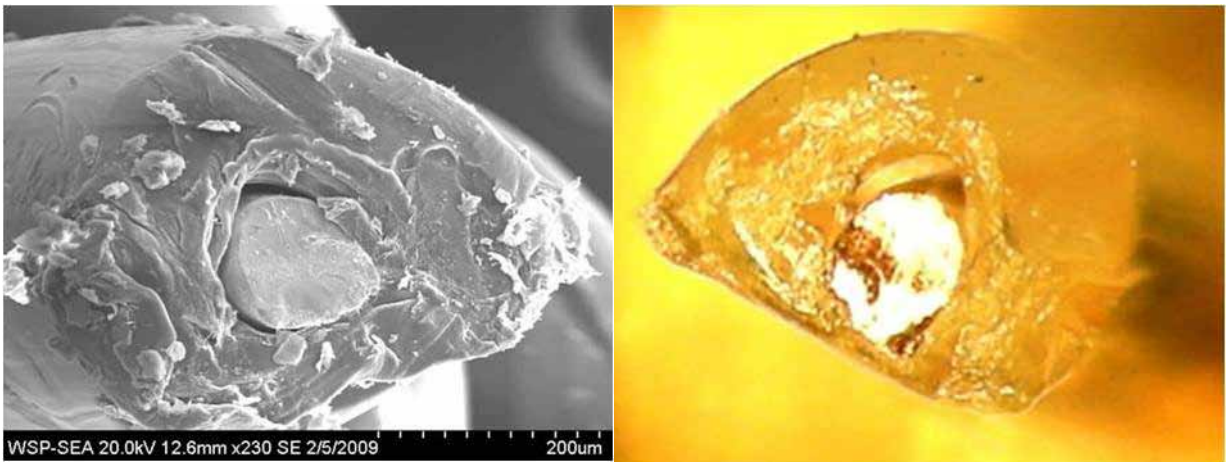
Figure 3: Scanning Electron Microscope SEM vs stereoscopic Examination



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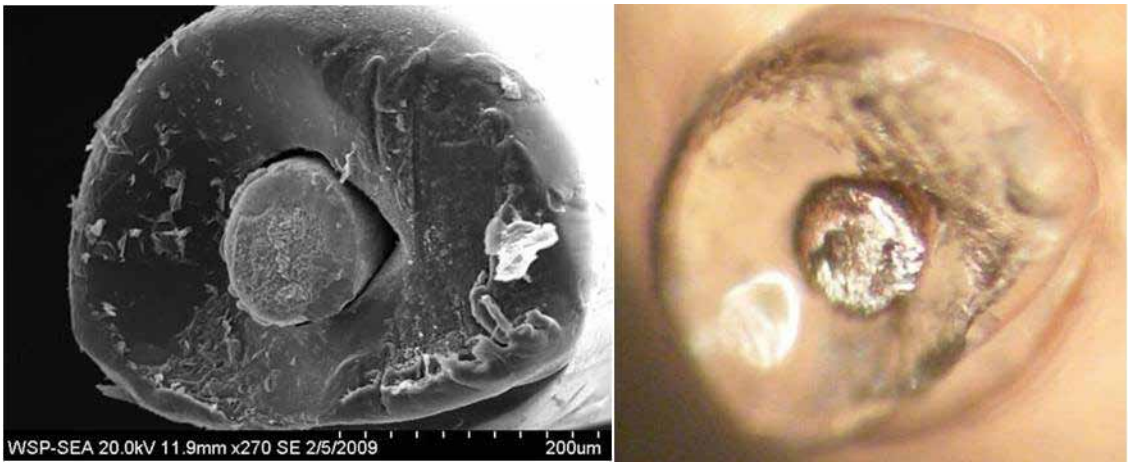

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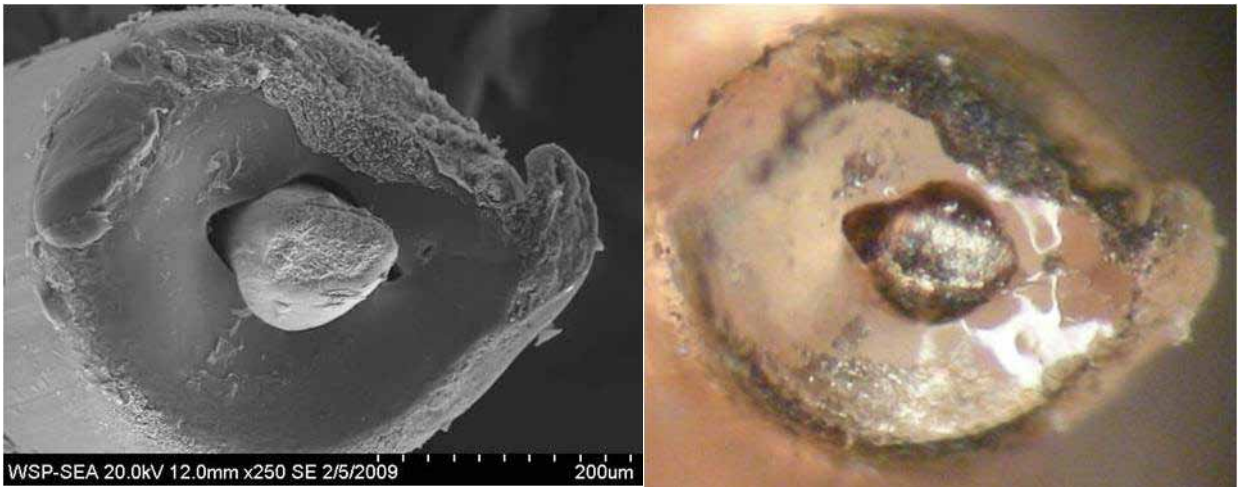

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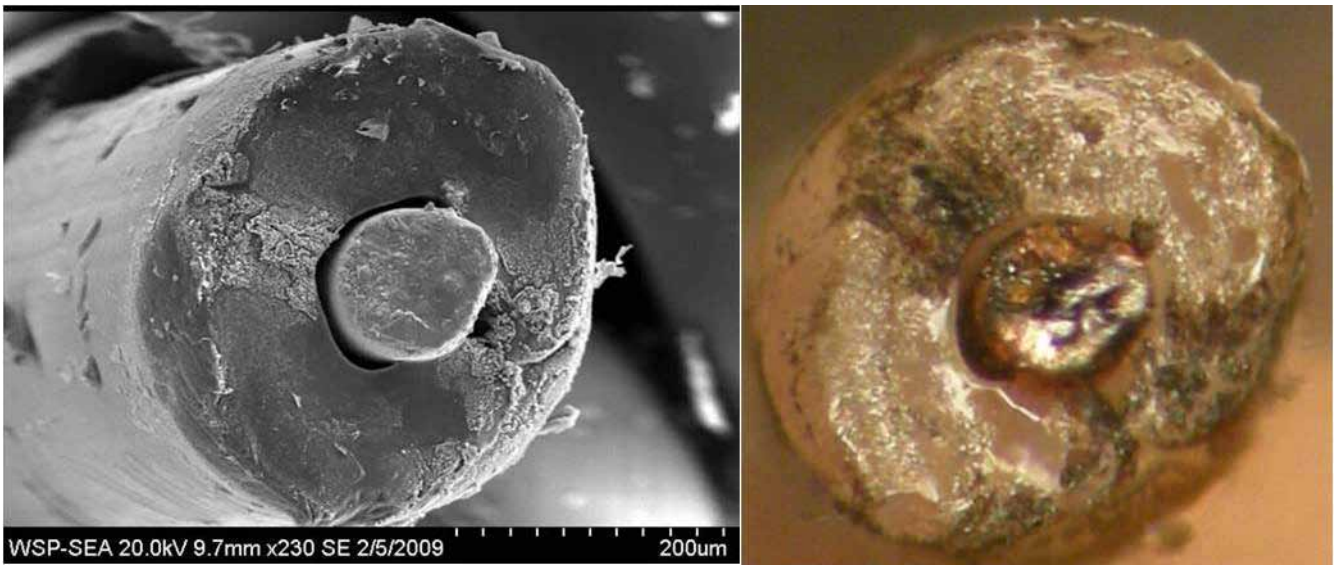
Figure 3 continued: Scanning Electron Microscope SEM vs stereoscopic Examination



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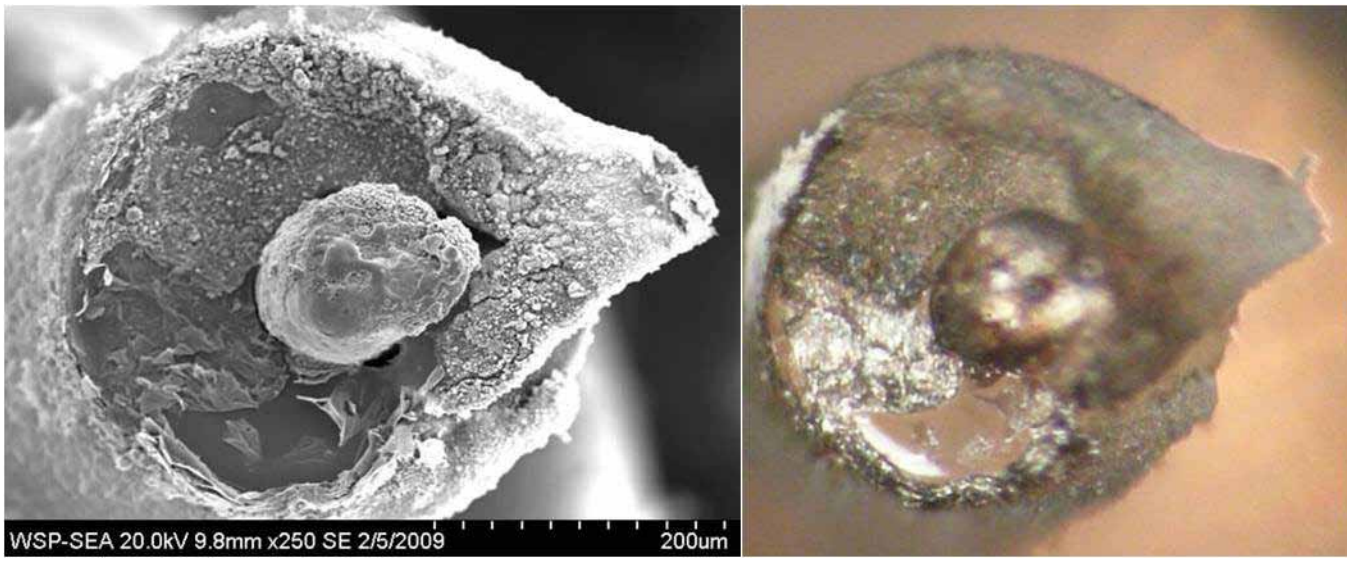

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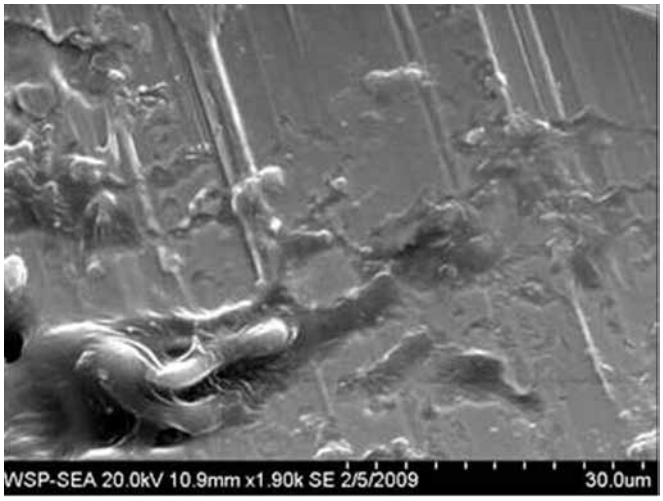
[1]Wyant, R.T. "The Advanced TASER M26, X26: Forensic Considerations," AFTE Journal, Vol. 36, No. 4, Fall 2004, pp.267-274.

[2] Kido, A., Wyant, R.T. "Analyzing Electronic Control Device (TASER) Wire to Determine Duration of Short Circuit." AFTE Journal, Vol. 40, No. 4, Fall 2008, pp.348-353.

[3] Presentation: 02/19/09 Richard T. Wyant, MS; Andrew Hinz, BS. "Examination of Electronic Control Device Probes to Determine Duration of Application", Presented at the 2009 American Academy of Forensic Scientists Meeting, Denver Colorado.

[4] Presentation: 06/02/09 Kathy Geil "Wire/Probe Junction Analysis on TASER Evidence" Presented at the 2009 Association of Firearms and Toolmark Examiners annual meeting Miami, FL.

Figure 4: High Magnification of Morphological Changes



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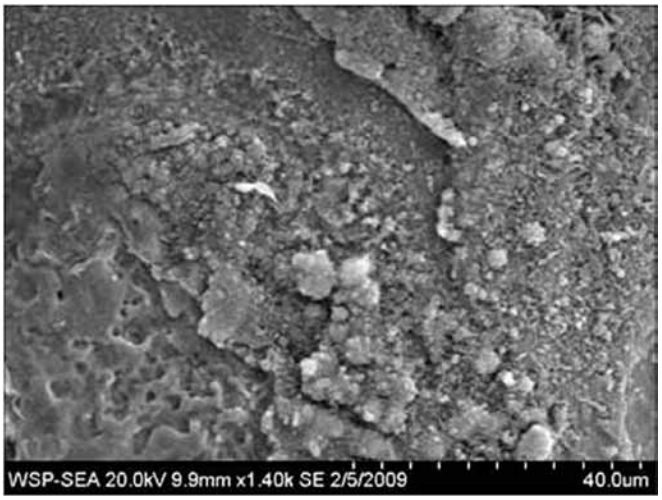

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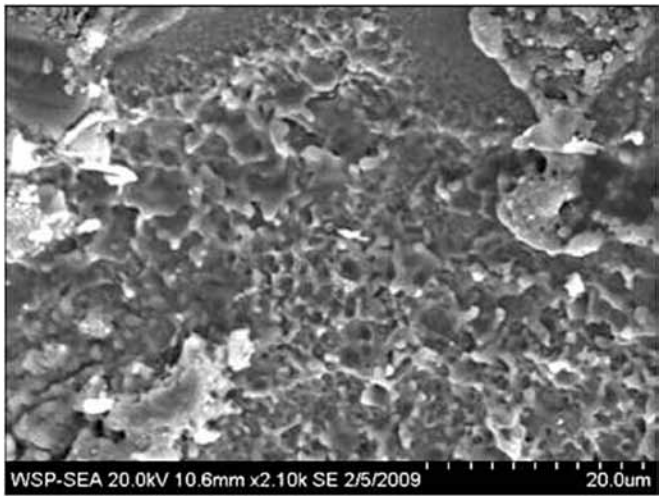

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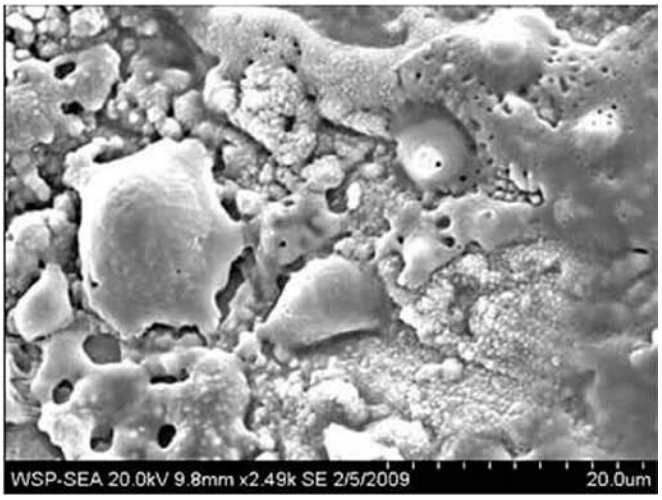

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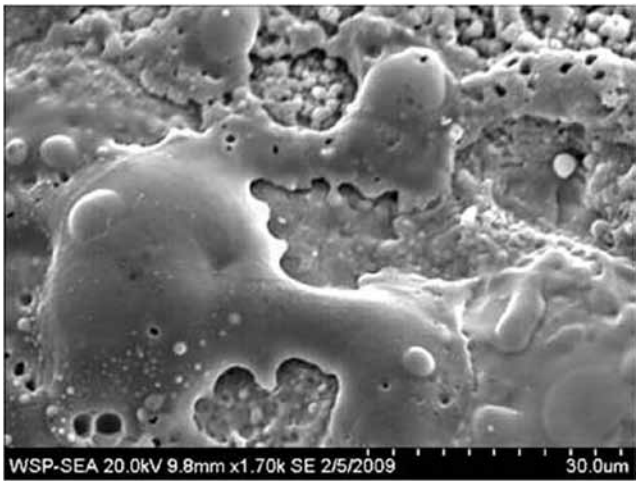

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Figure 5a: The new X3 model probe (Top) vs. the X26, M26, & C2 (Bottom)

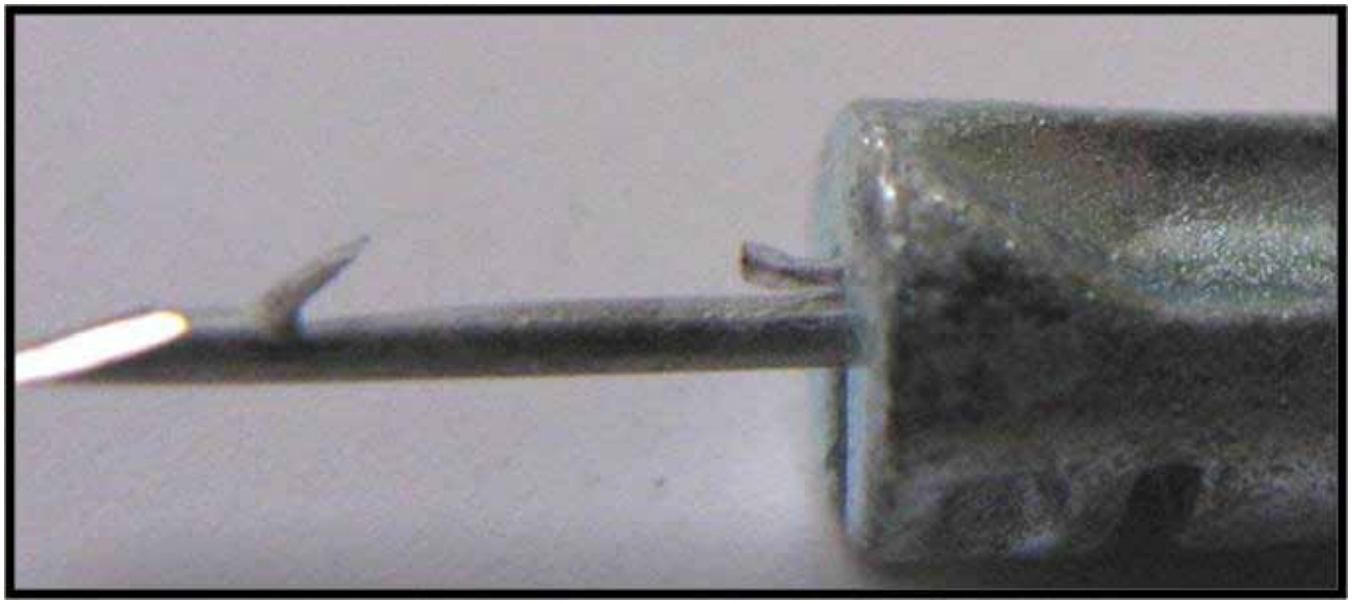

Figure 5b: Close-up of new X3 probe