University of Central Florida

Department of Chemistry

MEMORANDUM

TO: **Mr. John Ryan**
Armor Auto

FROM: **Dr. Christian Clausen III**
Professor of Chemistry

DATE: **January 14, 2005**

RE: **Studies conducted on Armor Coat PPC911 Coating**

As you know for the past three months I have been conducting performance studies on your Armor Coat clear after market paint protection coating. Specifically your request through the SATOP program was to get a second opinion on your product's stability and adhesion to a new car painted surfaces. Also, there was a request to determine if the coating is stable over time as the vehicle ages and that the product is functional in both cold as well as warm climates.

The first tests that were conducted consisted of a microscopic examination of the test panel that you sent to me that was coated with the Armor Coat product. The micrographs that were taken are presented in Appendix A. The three micrographs are listed as G4, G5, G6, and are taken at different magnifications, with the magnification listed on the micrograph. The white spots that you see in each of the micrographs correspond to opaque pieces of the polymer that are embedded in the polymer film. Upon high magnification such as in G6, holes can be seen in the surface of the polymer film. These holes are all approximately 45 micrometers in diameter. From the sample that you sent to me it was not possible to determine if the opaque pieces of polymer and holes in the surface were caused by your spraying procedure or is characteristic of the way that this polymer cures.

As a reference samples of metal parts coated with factory finished clear coat were obtained from two different General Motors vehicles and one from a Chrysler vehicle.

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Micrographs of the GM vehicles are labeled as S1, S2 and S3. The Chrysler vehicle is labeled as Y1 and Y2 as shown in Appendix B. What you see in theses surfaces is a clear coating with the painted surface underlying the clear coat. There are no holes in the surface and no pieces of opaque polymer in the polymer coat. It should be noted that the clear coat thickness for the GM and Chrysler finishes was approximately 3 mils, whereas the Armor Coat finish was approximately 8 mils thick.

The next test that was conducted was an accelerated ageing test that was performed using an ASTM G-53 accelerated weathering device equipped with UVA bulbs. A portion of the Armor Coat test panel was subjected to this test for 3 days. Fourier Transform Inframed Spectroscopy (FTIR) analysis was performed on the test panel before and after being exposed to UV. The spectra for these samples are shown in Appendix C.

The FTIR spectra for the before UV exposure, sample 5 and sample 6 are the same as the spectrum obtained after UV exposure sample 7. What this means is that because no new peaks appeared in the spectrum then the polymer film was not altered by the UV exposure. That is there was no breakage of the chemical bonds in the UV film.

Micrographs of the Armor Coat finish were also taken after exposure to UV radiation. These micrographs are shown in Appendix D. The micrographs show no physical change in the polymer film as a result of exposure to UV radiation.

Adhesion testing was also carried out on the Armor Coat finish both before and after exposure to UV radiation. The testing was carried out in accordance with the tape adhesion procedure prescribed by ASTM D3359. This method involves using a knife or other cutting tool to scribe a cross-hatch pattern into the panel, followed by the application of a special pressure-sensitive adhesive tape. The tape is then rapidly removed, and the adhesion is assessed in accordance with the method's rating system. Ratings can range from "5B" corresponding to no loss of adhesion, to a "0B" corresponding to 65% or more delaminating.

Ten tests were conducted on samples of the Armor Coat finish before exposure to UV radiation and the same number after exposure to UV radiation. The results before UV gave two; '5Bs', six "4Bs and two "3Bs". After UV exposure the results were one "5B', five "4Bs' and four "3Bs'. Similar results were obtained for the GM and Chrysler finishes, indicating that they all have similar adhesion and UV protection properties.

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The last test that was performed consisted of subjecting the test panels to a blast of sand particles (40 meshes) that has been accelerated to a velocity of 60 mph through an aerosol nozzle. The distance between the tip of the nozzle and the test panel was two feet. The duration of the test was three minutes.

A micrograph of the test panel after exposure to the accelerated sand particles is shown in Appendix E. As can be seen from the micrograph no visible pitting of the finish surface occurred. When the GM and Chrysler test panels were subjected to the same test, several pit marks could be observed to have formed in the sand impact area.

In summary all of my tests indicated that your product Armor Coat will perform up to the standards that you have listed in your Product Information Bulletin P-911.

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Appendix A

Micrograph of the Armor Coat finish as received from a sample panel supplied by Armor Auto

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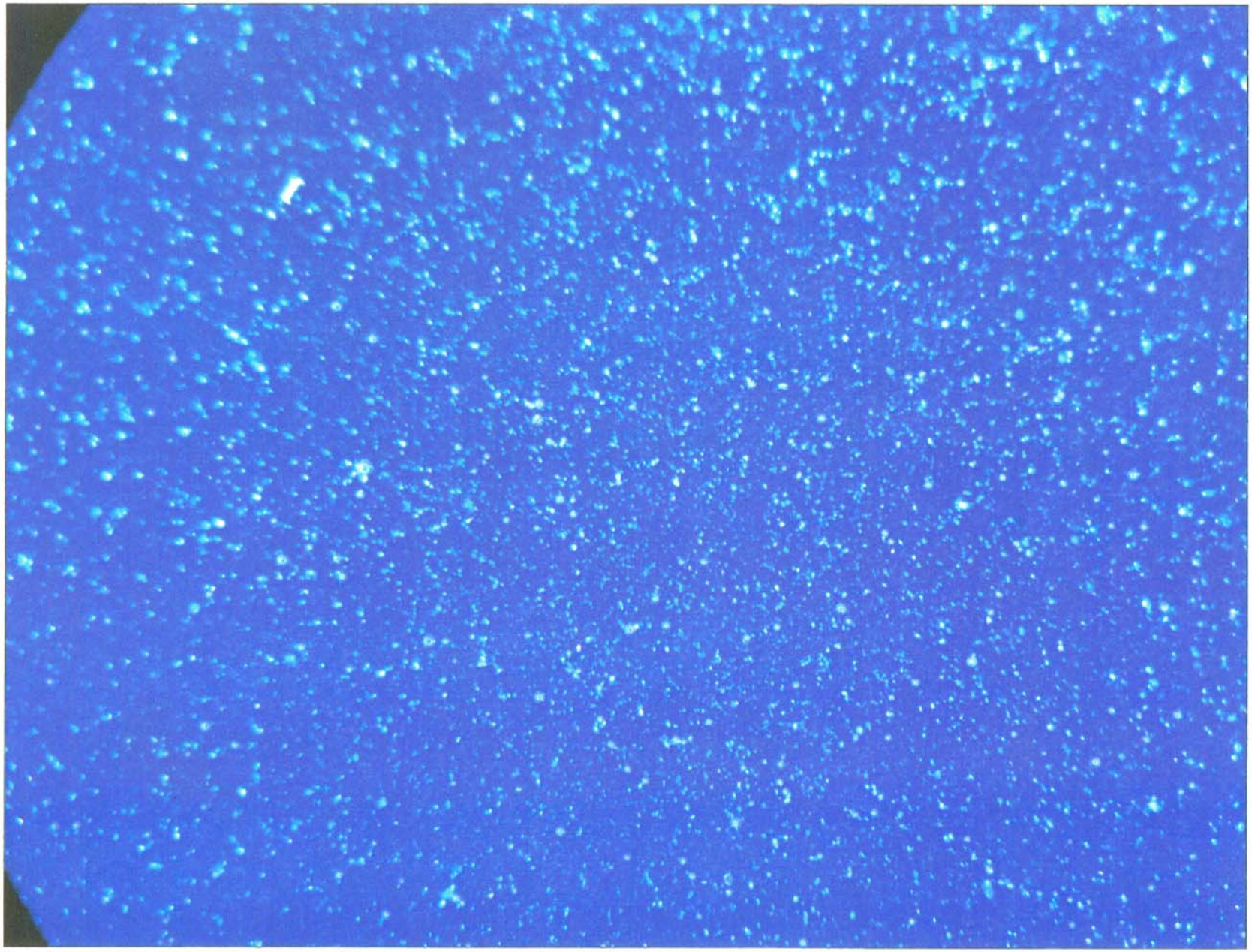
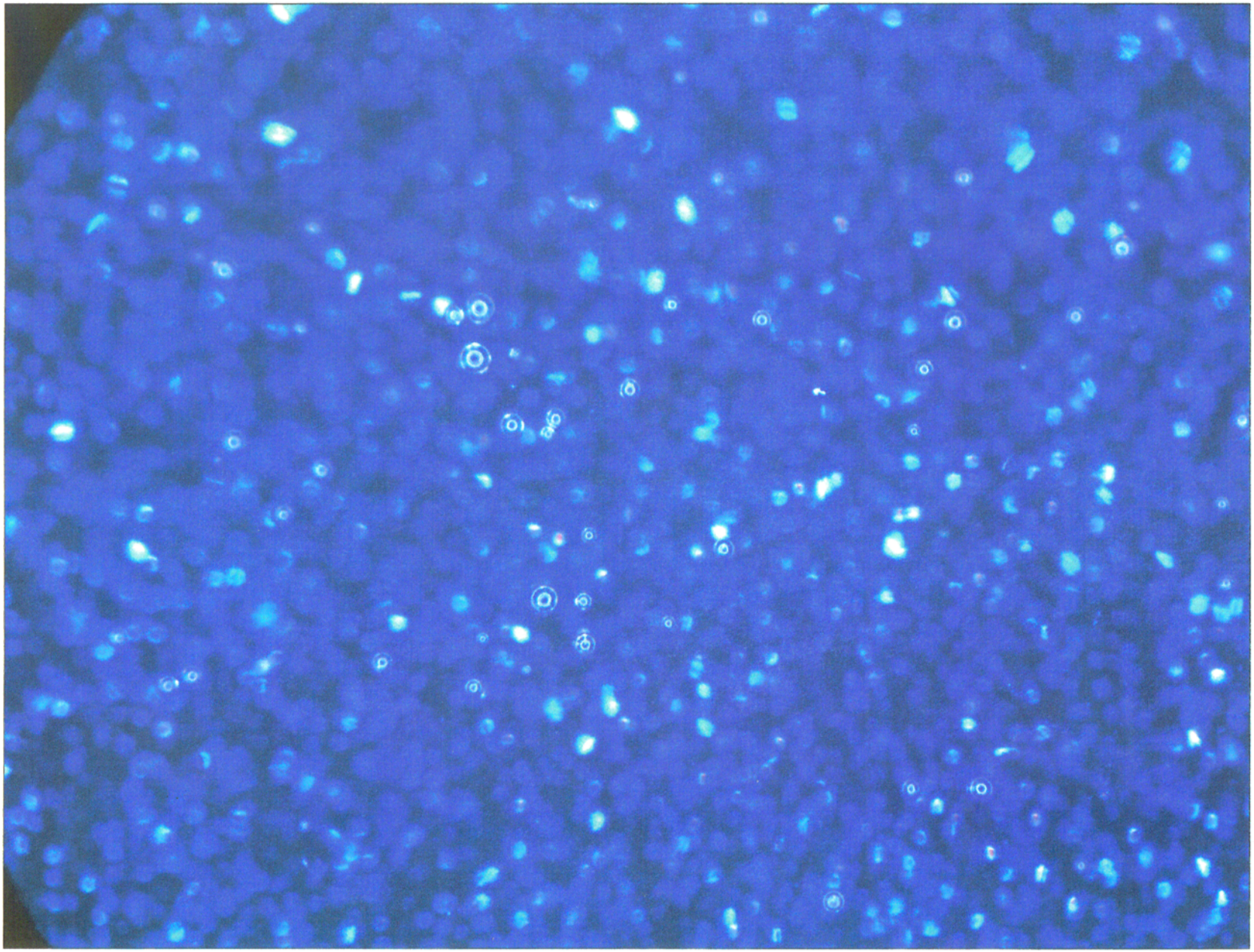
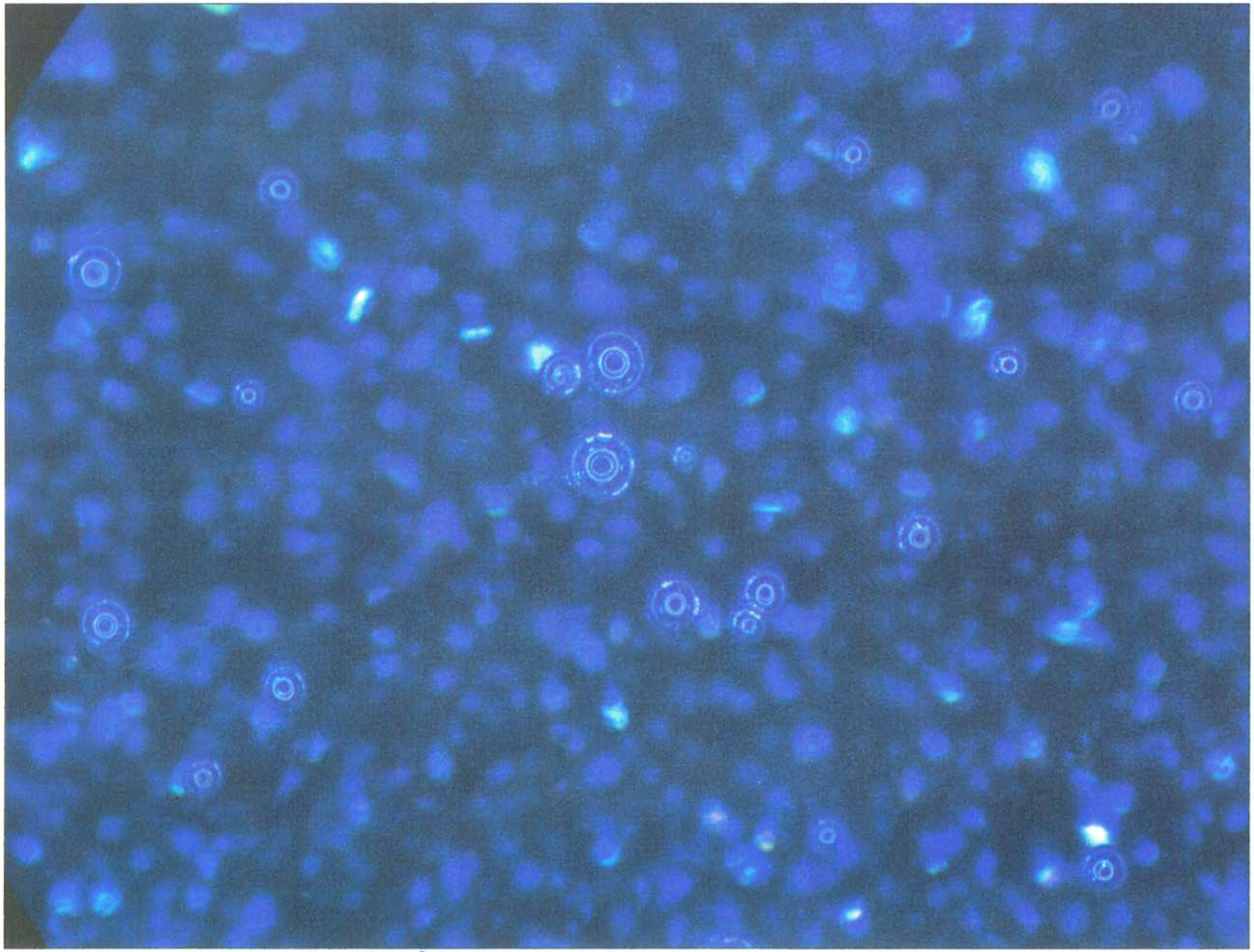


G4 at 1.0X (35.5X ArmorCoat Sample as Received



G5 at 3.0X (106X) ArmorCoat Sample as Received



G6 at 6.3X (224 X) ArmorCoat Sample as Received

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Appendix B

Micrograph of Factory Clear coat finishes for Representative General Motors and Chrysler Vehicles

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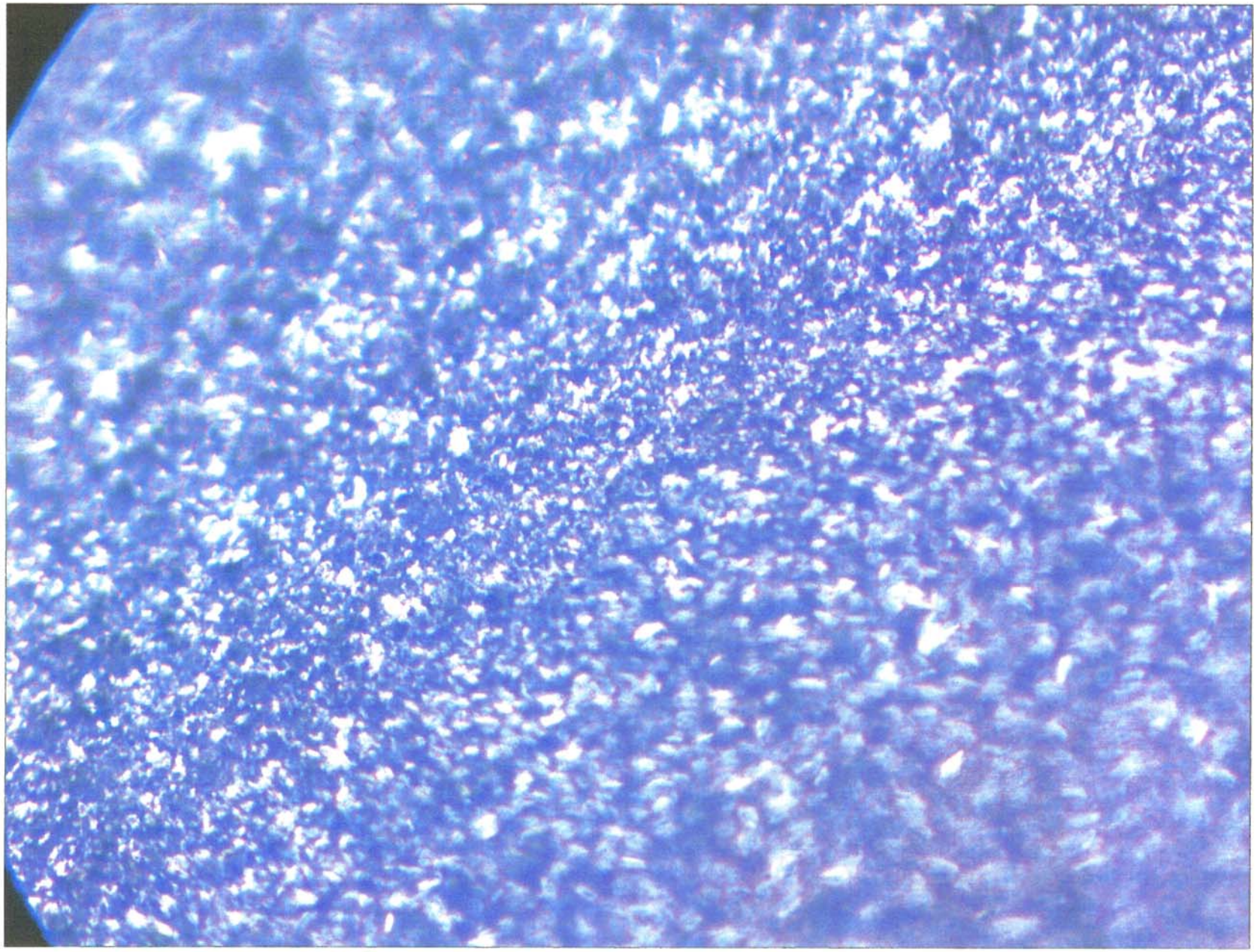
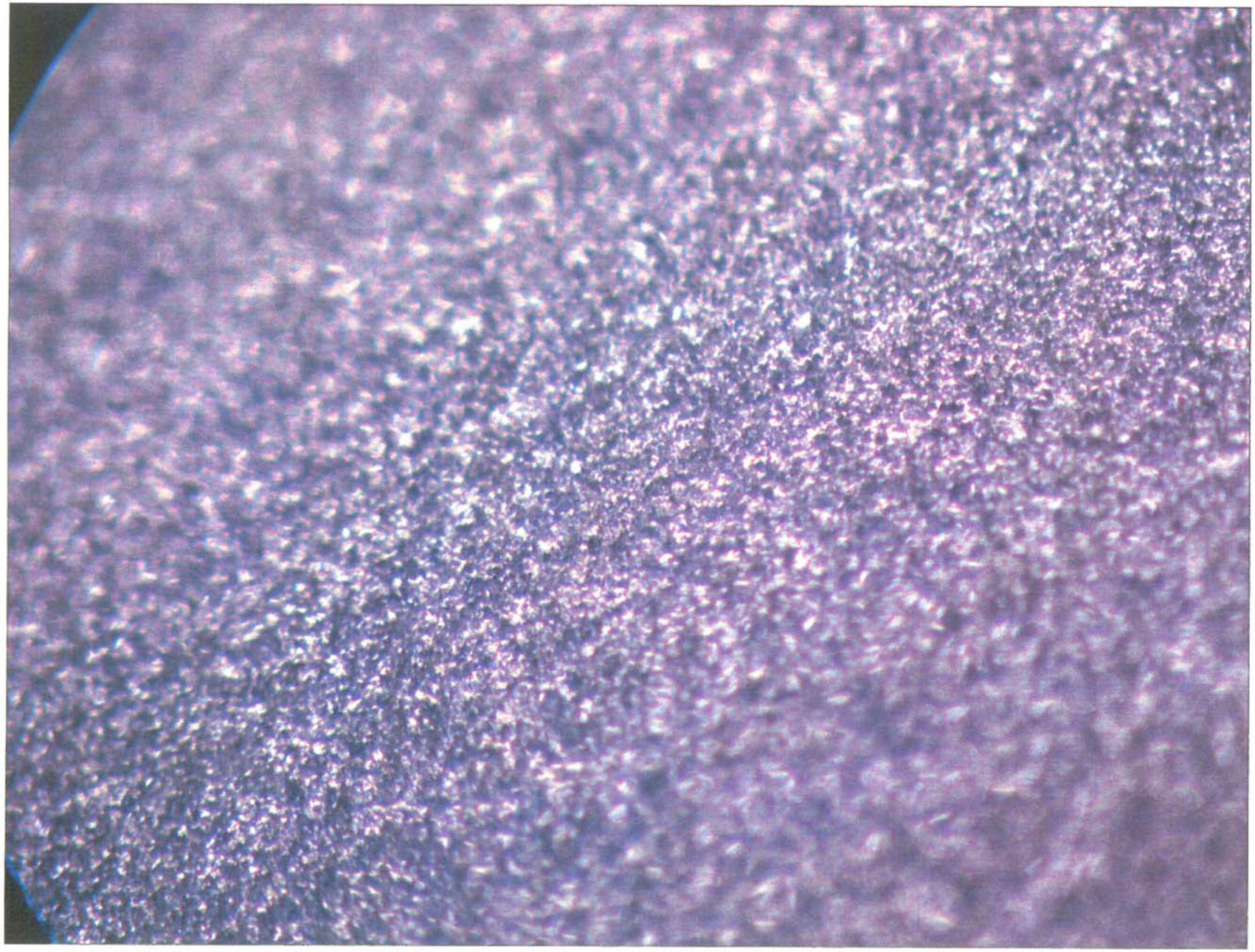
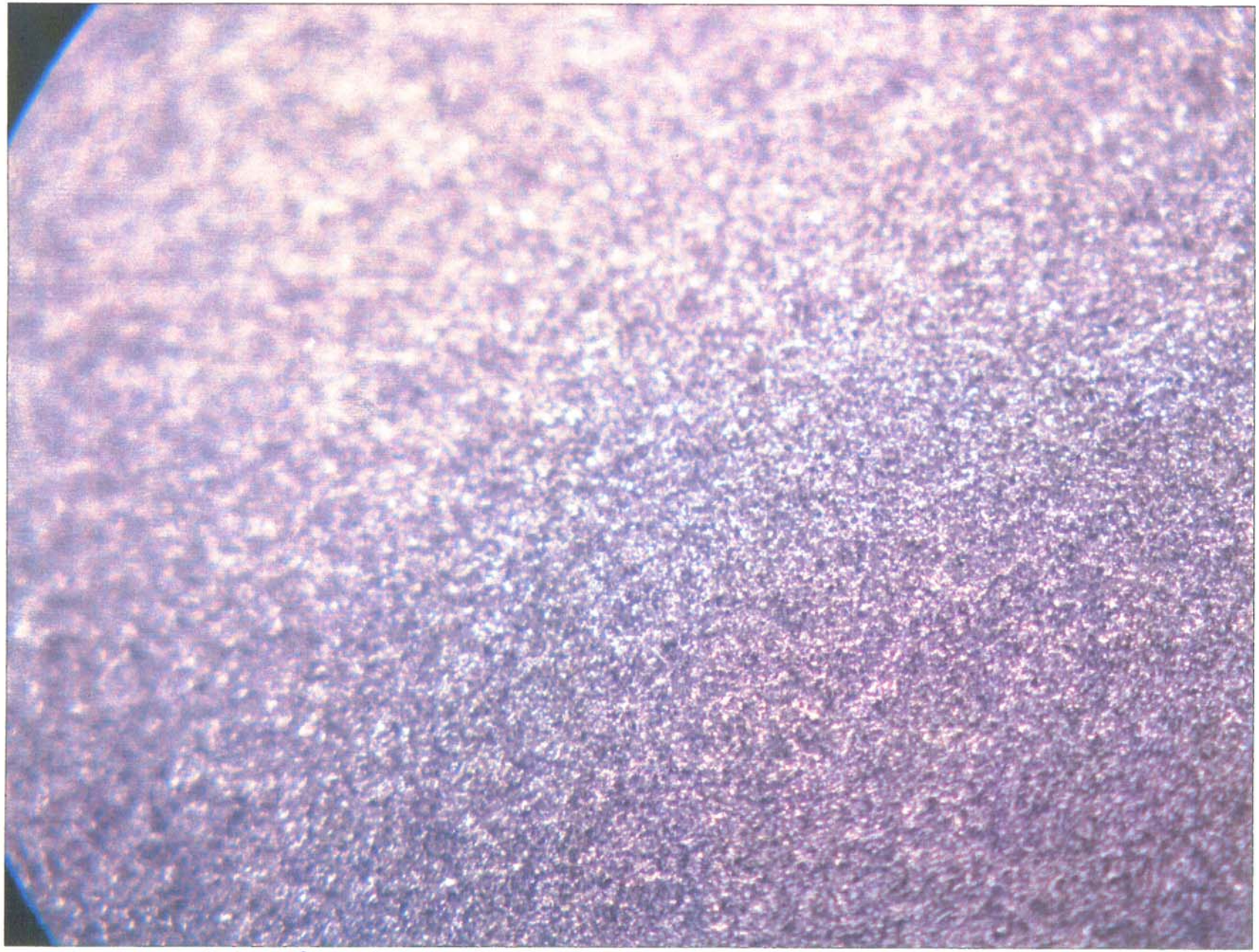


S1 at 6.3X (225X) GM finish



52 at 3.0X (106 X) GM finish



S2 at 3.0X (106x) GM finish

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Appendix C

FTIR Spectra of Armor Coat finish before and after exposure to UV radiation

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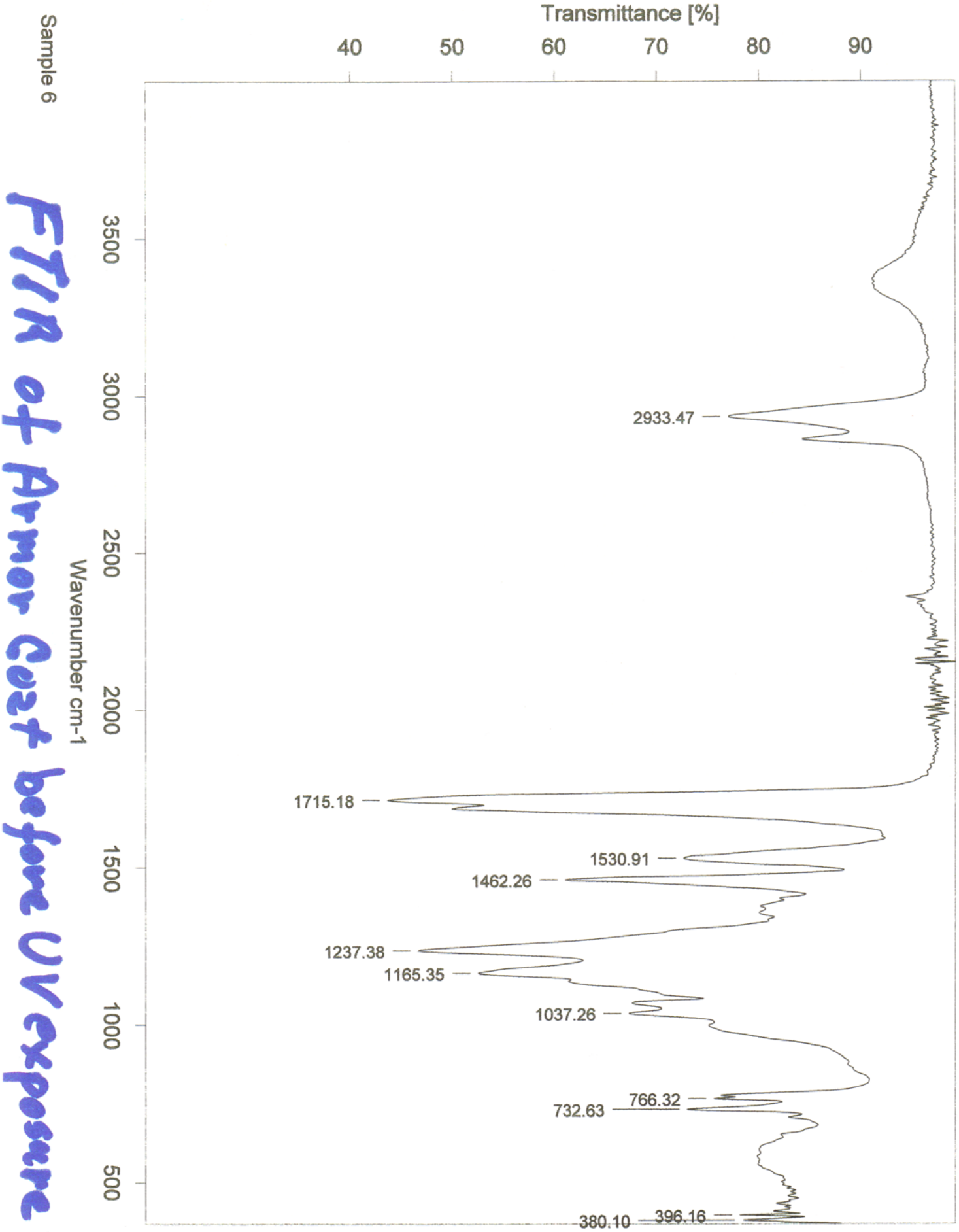
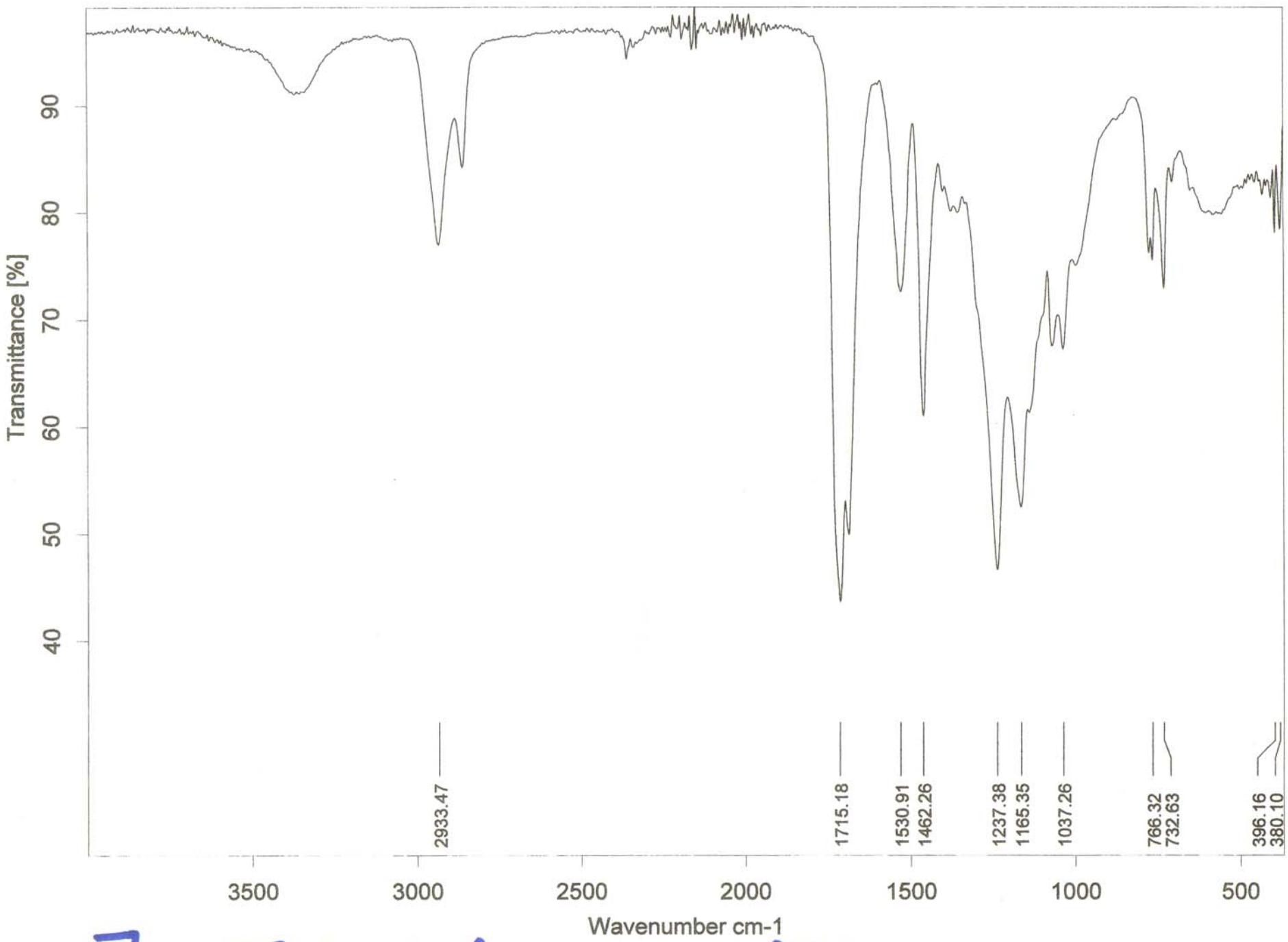


FTIR of Armor Coat before UV exposure



Sample 7 FTIR of ArmorCoat After UV exposure

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Appendix D

Micrographs of Armor Coat finish after UV exposure

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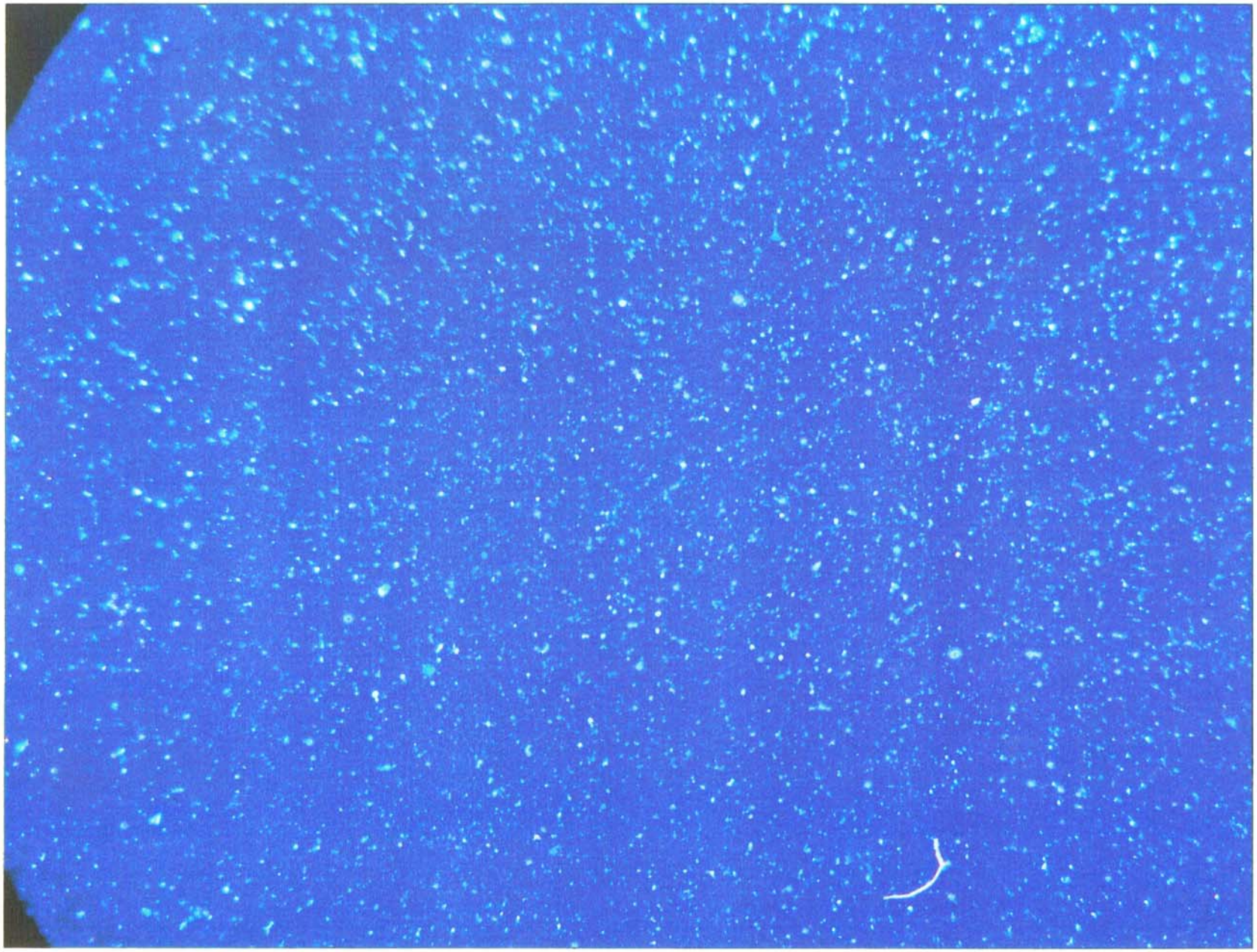
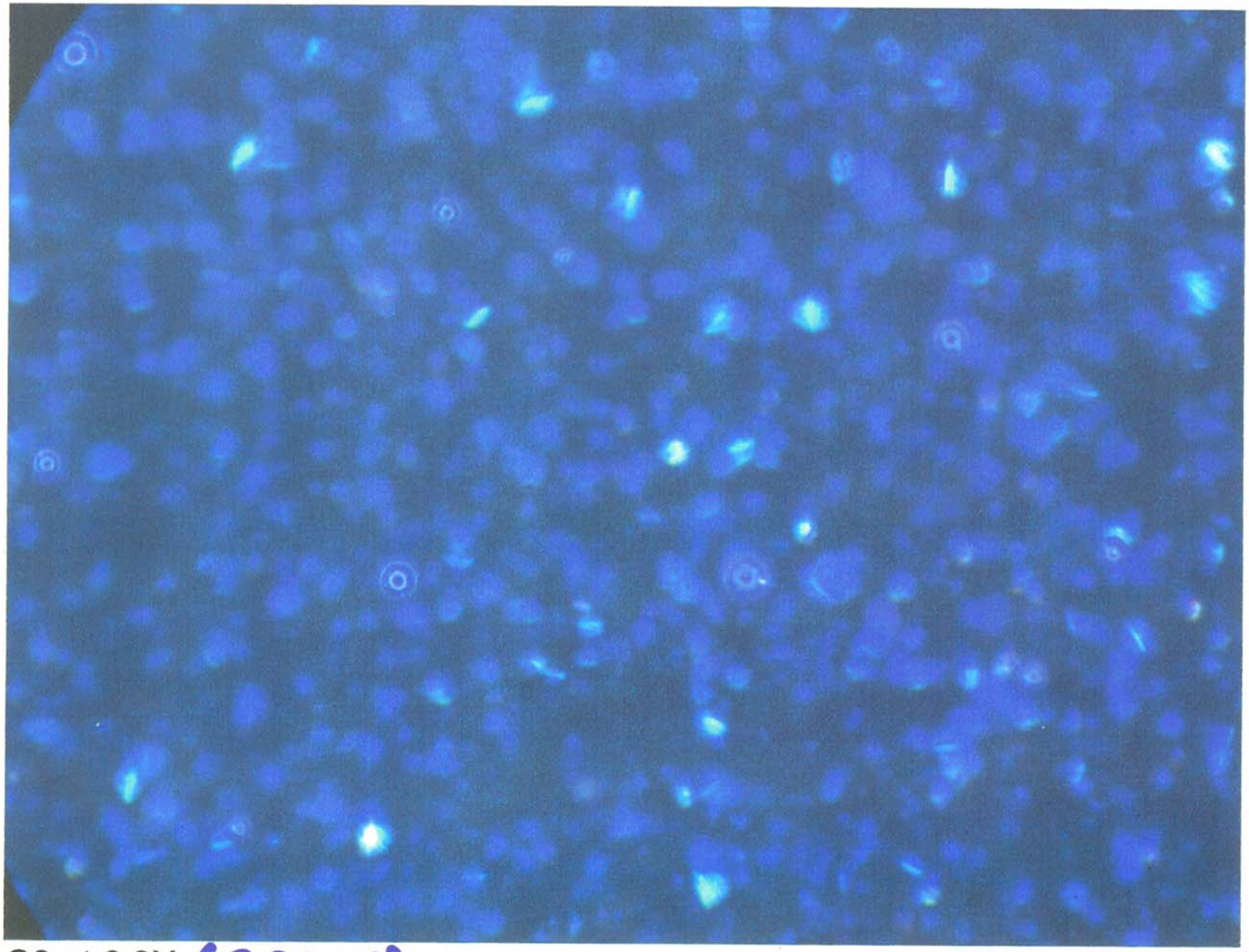


G1 at 1.0X (35.5X) ArmorCoat after UV exposure



G3 at 6.3X (224X) ArmorCoat after UV exposure

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Appendix E

Armor Coat finish after being subjected to Sand-blast Test

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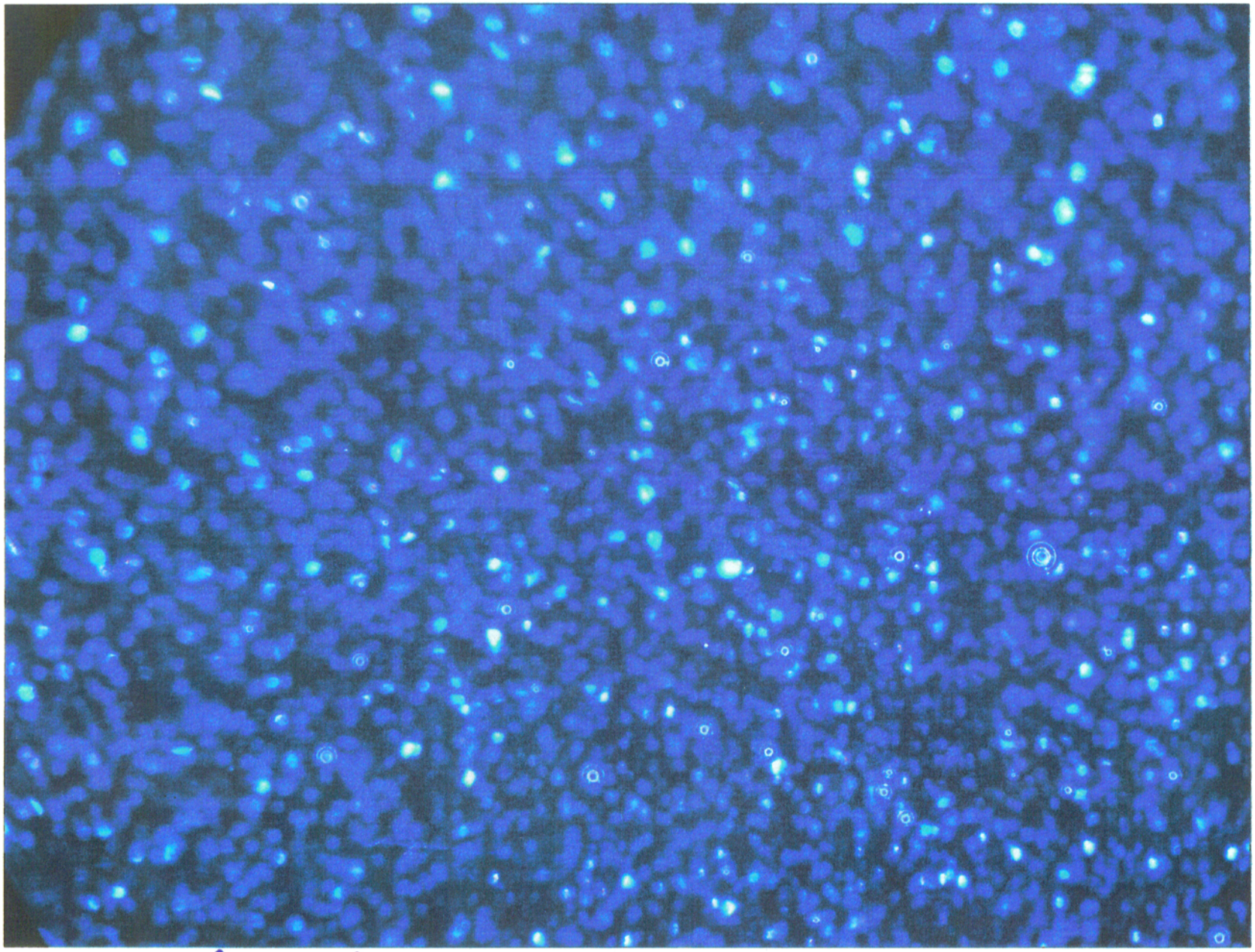

G2 at 2.6X (92X) ArmorCoat after Sand-Blast Test