

DEPARTMENT OF MINES AND RESOURCES  
BUREAU OF MINES  
CANADA

FILE COPY

Ottawa, November 26, 1946.

R E P O R T  
of the  
ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2145.

Metallurgical Examination of Surface Condition  
of 20-mm. A/P Shells.

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(Copy No. 6.)

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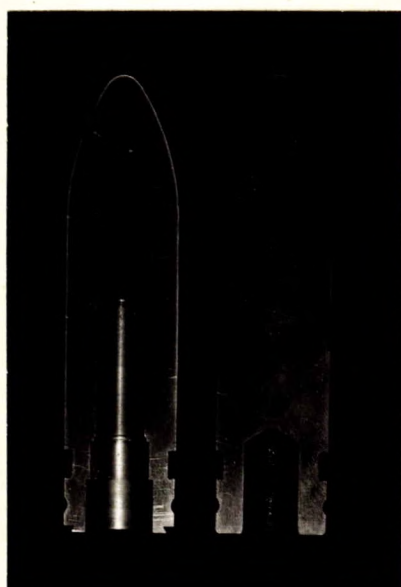
Origin of Material and Object of Investigation:

Following up Investigation Report No. 2129, issued on November 1, 1946, Mr. J. W. MacNaughton, for Chief Superintendent, Canadian Armament Research Development Establishment, Department of National Defence (Army), P.O. Box 1427, Quebec, Quebec, submitted two sets of 20-mm. A/P shells for examination. In a letter (File No. CARDE/30-184) dated November 6, 1946, he stated that the shells were obtained from the American Forces and that modifications on these shells were being attempted. This necessitated annealing the shells so that they could be machined. He was interested in learning whether the shells had been decarburized before or after annealing. With this in mind, five (5) shells were forwarded in the "as supplied" condition and five (5) in the annealed state.

Examination of Macro-Etched Samples:

One shell in the "as supplied" condition and one in the annealed state were wet-ground longitudinally until half the metal had been removed. Each shell was polished and etched in 2 per cent nital. Figure 1 illustrates the condition of the shells at the surface. The shell at the left is the annealed sample, while the one at the right is the "as received" specimen.

Figure 1.



Note white layer at the surface of the shell on the left.

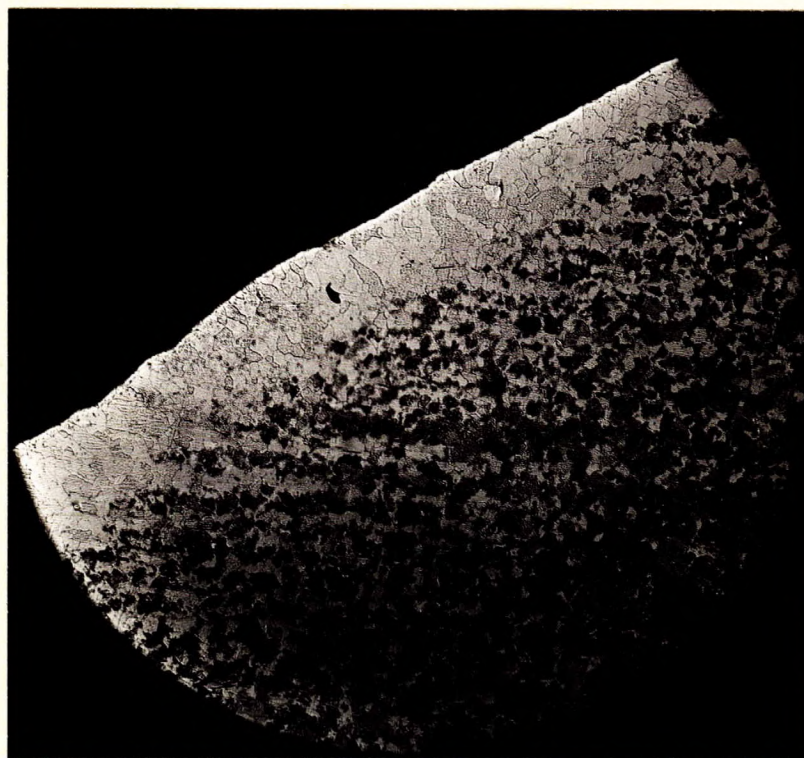
(Approximately 2/3 actual size.)

Microscopic Examination:

A transverse specimen was cut from an "as supplied" shell and from an annealed shell. These were polished, etched in 2 per cent nital, and examined under the microscope. Figure 2, taken at X100 magnification, illustrates the decarburized layer (white area at the surface) of the annealed shell. Figure 3, taken at X300 magnification, shows the surface of the "as supplied" shell.

(Microscopic Examination, cont'd) -

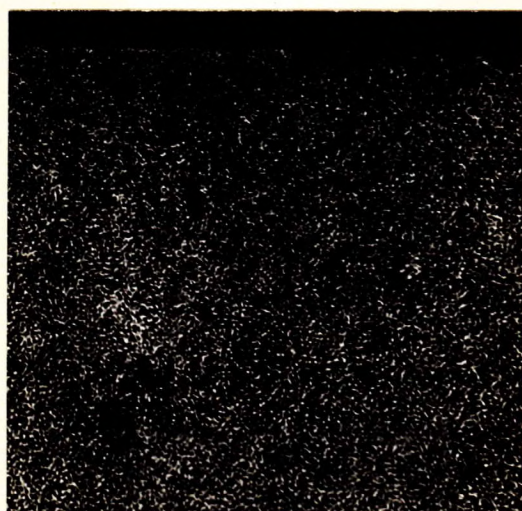
Figure 2.



X100, nitral etch.

ANNEALED SAMPLE.

Figure 3.



X300, nitral etch.

"AS SUPPLIED" SAMPLE.

Chemical Analysis:

In order to determine the extent of the decarburization on the annealed shell and to definitely establish whether there is any decarburization on the "as supplied" sample, 0.005-inch layers were successively machined from each shell and analysed for carbon content. The results were:

<u>Inches from the Surface</u>	<u>CARBON CONTENT PER CENT</u>	
	<u>"As Supplied" Shell</u>	<u>Annealed Shell</u>
0.005	0.47	0.05
0.010	0.51	0.05
0.015	0.51	0.14
0.020	1.51	0.26
0.025	1.51	0.30
0.030	1.51	0.35
0.035	0.52	0.38
0.040	0.52	0.44

Discussion:

The annealed sample has been decarburized for a depth exceeding 0.040 inch. The "as supplied" sample is slightly decarburized, since the first 0.005 inch contains 0.47 per cent carbon. This partial decarburization in the "as supplied" sample is not too serious provided that other shells are not more severely decarburized. The annealing operation is definitely decarburizing the shells. It is strongly recommended that the annealing and any subsequent heat treatments be carried out in a neutral atmosphere furnace or in a neutral salt bath.

Conclusions:

1. The annealed sample is decarburized for over 0.040 inch in depth.
2. The "as supplied" shell is very slightly decarburized, to a depth not exceeding 0.005 inch.

Recommendation:

The annealing operation, and all heat treatments after annealing, should be carried out in neutral atmosphere or neutral salt bath furnaces to prevent decarburization.

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