FFI RAPPORT

CONTACT SURFACE AREA OF RS-41

MOXNES John F, RYSJEDAL Jan H

FFI/RAPPORT-2000/04385

FFIBM/778/130

Approved
Kjeller 30 August 2000

Bjarne Haugstad
Director of Research

CONTACT SURFACE AREA OF RS-41

MOXNES John F, RYSJEDAL Jan H

FFI/RAPPORT-2000/04385

FORSVARETS FORSKNINGSINSTITUTT
Norwegian Defence Research Establishment
P O Box 25, NO-2027 Kjeller, Norway

FORSVARETS FORSKNINGSINSTITUTT (FFI)
Norwegian Defence Research Establishment

P O BOX 25
N0-2027 KJELLER, NORWAY

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

REPORT DOCUMENTATION PAGE

1) PUBL/REPORT NUMBER	2) SECURITY CLASSIFICATION	3) NUMBER OF PAGES
FFI/RAPPORT-2000/04385	UNCLASSIFIED	12
1a) PROJECT REFERENCE	**2a) DECLASSIFICATION/DOWNGRADING SCHEDULE**	
FFIBM/778/130	-	

4) TITLE

CONTACT SURFACE AREA OF RS-41

5) NAMES OF AUTHOR(S) IN FULL (surname first)

MOXNES John F, RYSJEDAL Jan H

6) DISTRIBUTION STATEMENT

Approved for public release. Distribution unlimited. (Offentlig tilgjengelig)

7) INDEXING TERMS

IN ENGLISH:	IN NORWEGIAN:
a) Multipurpose Ammunition	a) Flerbruksammunisjon
b) Pyrotechnic composition	b) Pyroteknisk sats
c) Contact surface area	c) Kontaktflateareal
d) Microscopic pictures	d) Mikroskopibilder
e) Luminosity	e) Lysintensitet

THESAURUS REFERENCE:

8) ABSTRACT

The pyrotechnic composition RS-41, a mixture of 49wt% KCLO4, 49wt% Al/Mg and 2wt% Calcium Resinat, is an important ingredient in the Multipurpose (MP) ammunition. RS-41 is placed in front of the projectile and ignites due to the impulse transfer on impact. A pyrotechnical combustion starts and spreads backward in the projectile and towards the explosive. This gives a delay, which is important for the fragmentation effect of the warhead.

In this report we have analysed the contact surface area of the particles in RS-41 as a function of the density by looking at the luminosity of the bulk surface of compressed pellets. We found that the contact area increased with the density in an s-shaped manner

9) DATE	AUTHORIZED BY	POSITION
	This page only	
30 August 2000	Bjarne Haugstad	Director of Research

ISBN-82-464-0462-8

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE
(when data entered)

CONTENTS

CONTACT SURFACE AREA OF RS-41

1 INTRODUCTION

The pyrotechnic composition RS-41, a mixture of 49wt% $KCLO_4$, 49wt% Al/Mg and 2wt% Calcium Resinat, is an important ingredient in the Multipurpose (MP) ammunition. RS-41 is placed in front of the projectile and ignites due to the impulse transfer on impact. A pyrotechnical combustion starts and spreads backwards in the projectile and towards the explosive. This gives a delay, which is important for the fragmentation effect of the warhead.

In this report we have analysed the contact surface area of the particles in RS-41 as a function of the density, by looking at the light intensity distribution of the bulk surface of compressed pellets. We found that the contact area increased with the density in an s-shaped manner.

We believe that a major part of the energy flux into the particles during impact passes through the contact surface. The contact surface is important in almost every hot-spot model for granular materials.

2 EXPERIMENTAL

Circular pellets were made in a compression mould, with a diameter of about 20mm and a thickness of about 3mm. Pictures of the bulk surface of each of the pellets were taken in a microscope with an attached digital camera, and directly imported into Adobe Photoshop 5.5. This program has the ability to generate a histogram of the light intensity, also called the luminosity, of the pictures. In the histogram the pixels are separated into 255 different intensity levels.

Description of the instruments used:

Microscope: Leica DMR
Objective: 10x/0.25 N Plan (Leica no. 556038)
Camera adapter: NIKON 10x (Leica no. 1016226/10404207/54514)

Camera: NIKON D1
Pictures size: 1300x2000 pixels
Colours: 8 bits RGB

The total magnification of the bulk surface was 100 times into the camera. This magnification only controls how much of the surface that will be captured by the camera, and generated into a picture of 1300x2000 pixels. A picture of a reticule plate gives the number of pixels in one millimetre, and for this magnification this number is 2700. Each picture covers therefore 0.48x0.74mm of the bulk surface. When the picture is printed on a screen, the real magnification will be a combination of the size and resolution of the screen. When the picture

is printed on a paper the magnification is relative to the number of pixels per inch, set in the software program used to print the picture (e.g. Adobe Photoshop).

3 RESULTS

Typical pictures of bulk surfaces are given in Figure 3.1 and Figure 3.2, and the luminosity histogram for the picture in Figure 3.2 is given in Figure 3.3. A well-squeezed and flat surface will reflect most of the incident light into the objective and further into the camera, and give a high number of pixels in the right part of the histogram. A rough surface will instead spread the incident light in all directions and very little light will be reflected into the camera. A higher pressure in the compression mould will therefore give a higher number of pixels in the right side of histogram. At the same time a higher pressure will also raise the contact surface between the particles. We suggest therefore that there is at relation between the relative contact surface area between the particles and the relative number of pixels in the right part of the histogram. A flat surface is here defined as all the pixels in the range from 210 to 255 in the luminosity histogram.

We have used five different pressures in the compression mould. Table 3.1 and Figure 3.4 show the relevant numbers. There are ten pictures for each pellet, and two pellets for each pressure. We observe that the flat bulk surface area increases with the pressure in the compression mould up to a maximum at about 400MPa.

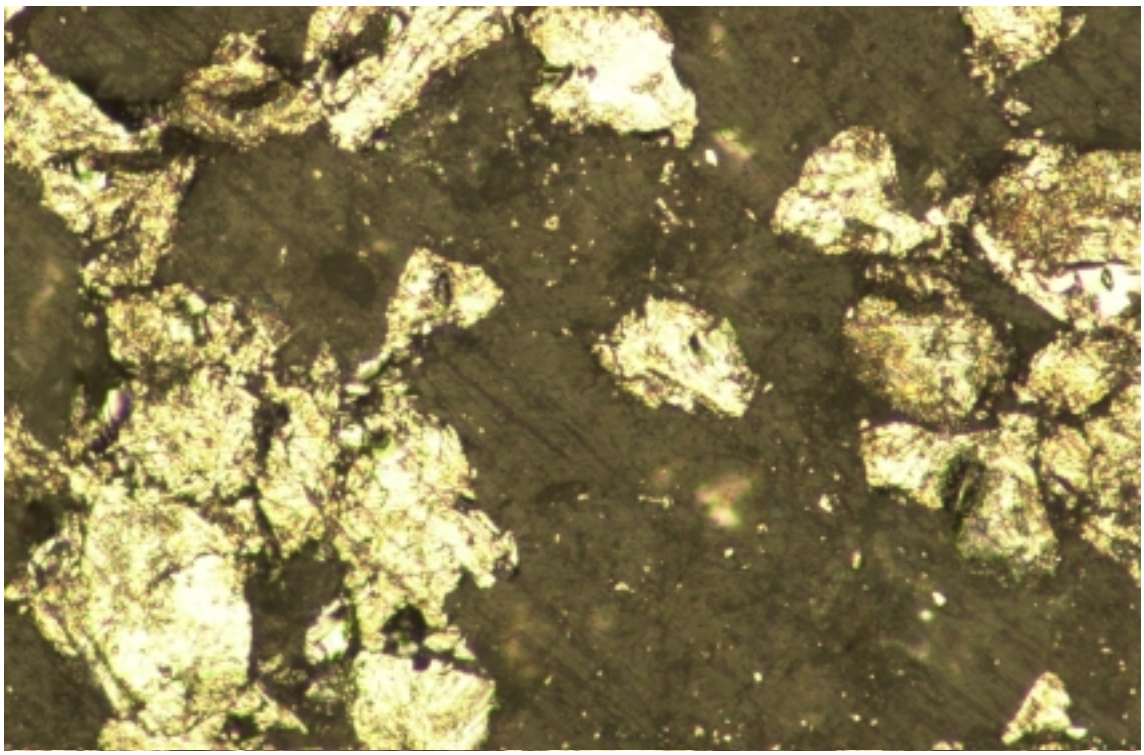

Figure 3.1 Typical picture of the bulk surface of a pellet pressed with 1GPa

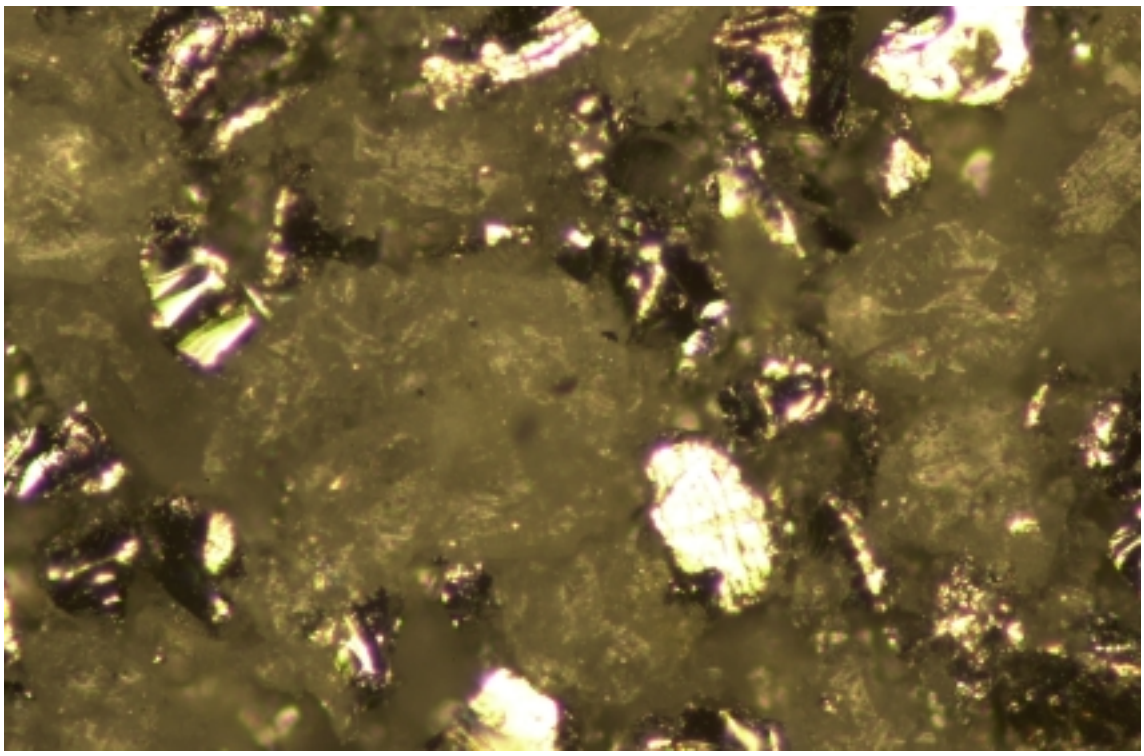

Figure 3.2 Typical picture of the bulk surface of a pellet pressed with 50MPa

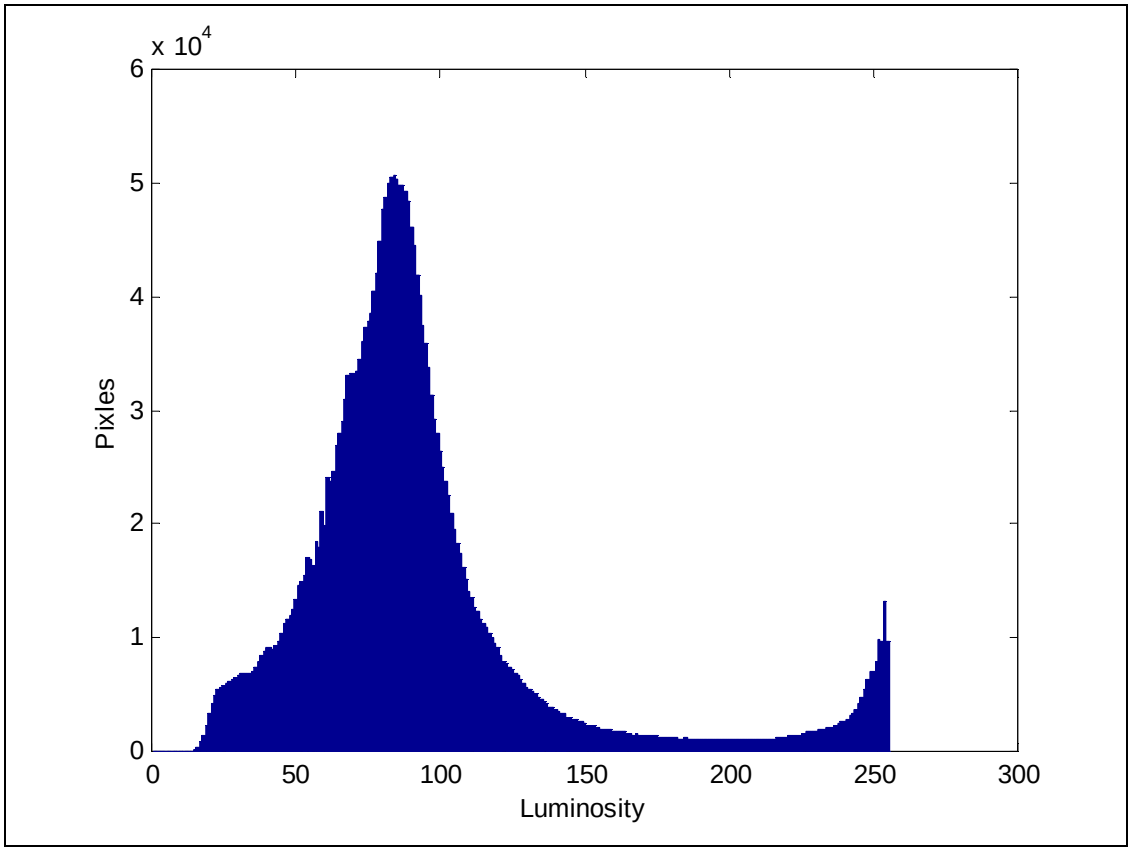

Figure 3.3 Typical histogram of the luminosity

Specimen ID.	Compression pressure (MPa)	Number of pixels defined as flat surface	Flat surface area (normalised)	Average flat surface area (normalised)
Pt0409b	1000	429372	0.93	1.00
Pt0409d	1000	490978	1.07	
Pt2106h	500	408380	0.89	0.92
Pt2106t	500	434811	0.95	
Pt2206a	300	407919	0.89	0.95
Pt2206c	300	466482	1.01	
Pt2206e	100	223107	0.49	0.49
Pt2206g	100	231225	0.50	
Pt2206i	50	162943	0.35	0.29
Pt2206k	50	105841	0.23	

Table 3.1 Relevant numbers for determination of the flat surface area for the different pellets

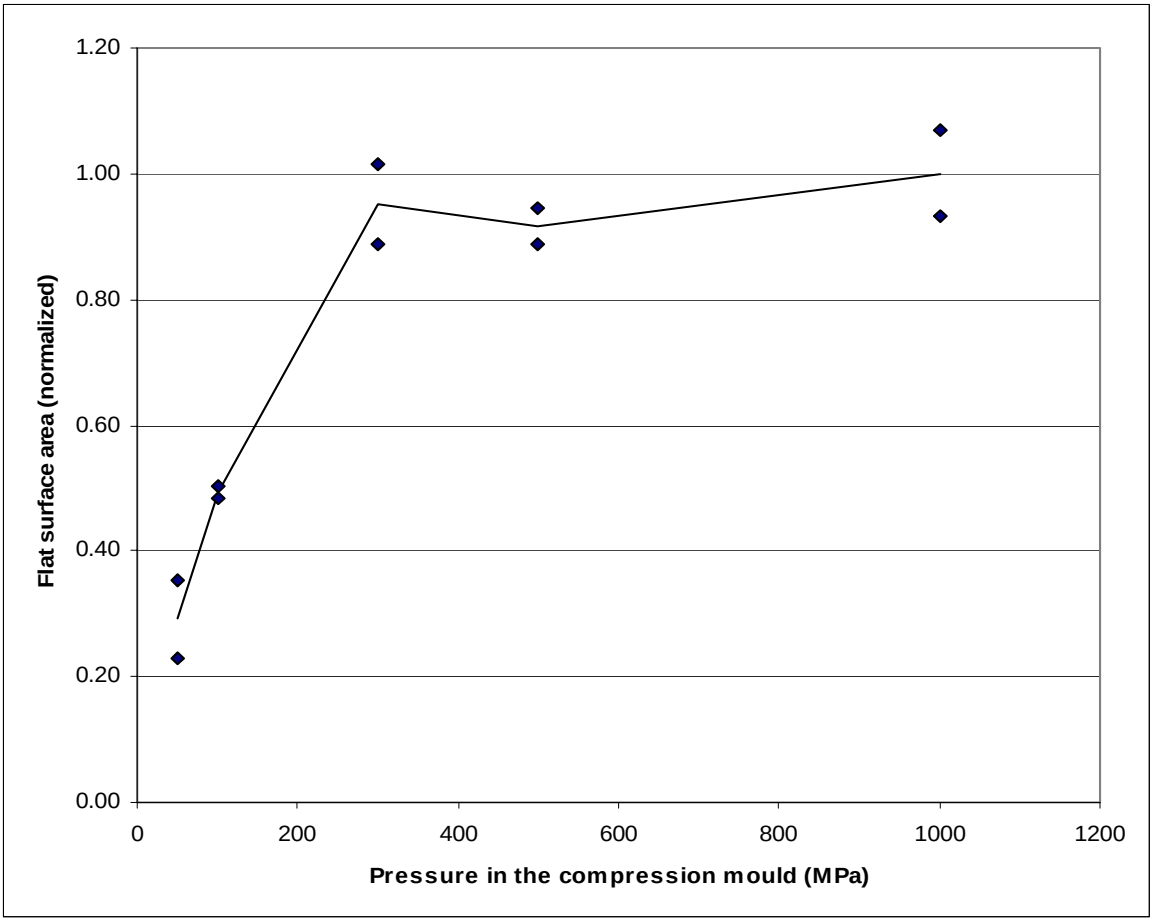

Figure 3.4 Flat surface area versus the pressure in the compression mould

4 CONCLUSION AND DISCUSSION

We have shown that the light intensity for the pressed particles increases with the pressure and reach an asymptote.

We have put forward the hypothesis that this curve is closely related to the relative contact area between the particles.

Later we will compare our new experimental curve with other curves for the relative surface contact area.

DISTRIBUTION LIST

FFIBM **Dato:** 30 august 2000

RAPPORTTYPE (KRYSS AV)	RAPPORT NR.	REFERANSE	RAPPORTENS DATO
X RAPP ☐ NOTAT ☐ RR	2000/04385	FFIBM/778/130	30 august 2000
RAPPORTENS BESKYTTELSESGRAD		ANTALL EKS UTSTEDT	ANTALL SIDER
Unclassified		27	12
RAPPORTENS TITTEL		FORFATTER(E)	
CONTACT SURFACE AREA OF RS-41		MOXNES John F, RYSJEDAL Jan H	
FORDELING GODKJENT AV FORSKNINGSSJEF:		FORDELING GODKJENT AV AVDELINGSSJEF:	

EKSTERN FORDELING

ANTALL	EKS NR	TIL
1		Nammo Raufoss AS
1		Onno Verberne
1		Gard Ødegårdstuen
1		Eva Friis
1		Quac Bao Diep
		Postboks 162
		2831 Raufoss
1		Naval Air Warefare Center Weapons
		Division, China Lake, CA 93555-6100
		US
1		Alice I. Atwood
1		Allen Lindfors
1		Combustion Research Section
		Naval Air Warefare Center Weapons
		Division, Code 4T4310D, 1
		Administration Circle
		China Lake, CA 93555-6100
		US
1		NAWC, Crane
1		David Holt
		www.ffi.no

INTERN FORDELING

ANTALL	EKS NR	TIL
2		FFI-Bibl
1		Adm direktør/stabssjef
1		FFIE
1		FFISYS
6		FFIBM
1		Bjarne Haugstad, FFIBM
1		Svein W Eriksen, FFIBM
1		John F. Moxnes, FFIBM
1		Gunnar Ove Nevstad, FFIBM
1		Jan H Rysjedal, FFIBM
		FFI-veven

FFI-K1 Retningslinjer for fordeling og forsendelse er gitt i Oraklet, Bind I, Bestemmelser om publikasjoner for Forsvarets forskningsinstitutt, pkt 2 og 5. Benytt ny side om nødvendig.