



University of Groningen

## Stabilizing CrO by epitaxial growth

Rogojanu, Oana Corina; Sawatzky, G.A; Tjeng, L.H

**IMPORTANT NOTE:** You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

### *Document Version*

Publisher's PDF, also known as Version of record

### *Publication date:*

2002

[Link to publication in University of Groningen/UMCG research database](#)

### *Citation for published version (APA):*

Rogojanu, O. C., Sawatzky, G. A., & Tjeng, L. H. (2002). Stabilizing CrO by epitaxial growth. Groningen: s.n.

### **Copyright**

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

### **Take-down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Stabilizing CrO by epitaxial growth



The work described herein was performed in the Solid State Physics Group (part of the Material Science Centre) of the University of Groningen, the Netherlands, and was financially supported by Stichting FOM.

Printed by: Stichting Drukkerij Regenboog Groningen

RIJKSUNIVERSITEIT GRONINGEN

# Stabilizing CrO by epitaxial growth

Proefschrift

ter verkrijging van het doctoraat in de  
Wiskunde en Natuurwetenschappen  
aan de Rijksuniversiteit Groningen  
op gezag van de  
Rector Magnificus, dr. D.F.J. Bosscher  
in het openbaar te verdedigen op  
maandag 15 april 2002  
om 16.00 uur

door

Oana Corina Rogojanu

geboren op 8 januari 1973  
te Hunedoara (Roemenie)

Promotores: Prof. Dr. G.A. Sawatzky  
Prof. Dr. L.H. Tjeng

Beoordelingscomissie: Prof. Dr. T. Hibma  
Prof. Dr. L. Niesen  
Prof. Dr. G. Güntherodt

*to Octavian*

# Contents

<b>1</b>	<b>Introduction</b>	<b>3</b>
<b>2</b>	<b>Experimental methods</b>	<b>11</b>
2.1	Growth of oxide thin films using molecular beam epitaxy . . . . .	11
2.1.1	General considerations . . . . .	11
2.1.2	MBE set-ups . . . . .	12
2.1.3	Substrate preparation and cleaning . . . . .	15
2.1.4	The choice of oxidation gas . . . . .	15
2.2	Analyzing techniques . . . . .	15
2.2.1	<i>In situ</i> RHEED and LEED . . . . .	15
2.2.2	<i>In situ</i> XPS . . . . .	16
2.2.3	<i>Ex situ</i> XRD and RBS/channelling . . . . .	17
2.2.4	<i>Ex situ</i> XAS . . . . .	18
<b>3</b>	<b><math>NO_2</math> assisted chromium oxides growth</b>	<b>23</b>
3.1	Introduction . . . . .	23
3.2	Sample preparation and experimental . . . . .	24
3.3	<i>In situ</i> structural analysis . . . . .	26
3.3.1	RHEED . . . . .	26
3.3.2	LEED . . . . .	33
3.4	Reference sample . . . . .	34
3.5	XPS results . . . . .	37
3.5.1	Sample chemical composition . . . . .	37
3.5.2	Electronic structure . . . . .	43
3.6	<i>Ex situ</i> structural analysis . . . . .	53
3.6.1	RBS/channeling . . . . .	53
3.6.2	XRD . . . . .	56
3.7	XAS results . . . . .	60

---

3.8	Conclusions . . . . .	63
<b>4</b>	<b><math>O_2</math> and <math>O_3</math> assisted chromium oxides growth</b>	<b>67</b>
4.1	Introduction . . . . .	67
4.2	$O_2$ assisted growth . . . . .	67
4.2.1	<i>In situ</i> structural analysis: RHEED . . . . .	68
4.2.2	Chemical composition . . . . .	73
4.2.3	Reconstruction seen by RHEED and LEED . . . . .	74
4.3	$O_3$ assisted growth . . . . .	79
4.3.1	Sample growth . . . . .	79
4.3.2	<i>In situ</i> structural analysis: RHEED and LEED . . . . .	80
4.3.3	XPS results . . . . .	90
4.3.4	<i>Ex situ</i> structural analysis . . . . .	99
4.3.5	XAS results . . . . .	103
4.4	Conclusions . . . . .	105
	<b>Summary</b>	<b>107</b>
	<b>Samenvatting</b>	<b>111</b>
	<b>List of acronyms</b>	<b>115</b>
	<b>List of Publications</b>	<b>117</b>
	<b>Acknowledgements</b>	<b>119</b>