## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration</td>
<td>ii</td>
</tr>
<tr>
<td>Certificate</td>
<td>iii</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>iv</td>
</tr>
<tr>
<td>List of publications</td>
<td>vii</td>
</tr>
<tr>
<td>Preface</td>
<td>xi</td>
</tr>
</tbody>
</table>

### Chapter 1 Introduction

1.1 History, Classification and uses of Inorganic pigments                2
1.2 Color properties                                                     6
1.3 Objectives of the present investigation                               15
1.4 Recent advances on the design and development of rare earth based inorganic pigments
  1.4.1 Rare earth based blue inorganic pigments                           17
  1.4.2 Rare earth based green inorganic pigments                          18
  1.4.3 Rare earth based red inorganic pigments                            19
  1.4.4 Rare earth based yellow inorganic pigments                         23
  1.4.5 Infrared Reflective Rare earth based Inorganic Pigments            28

### Chapter 2 The synthesis, characterization and optical properties of Si$^{4+}$ and Pr$^{4+}$ doped $Y_6MoO_{12}$ compounds: Environmentally benign inorganic pigments with high NIR reflectance

**Summary** 30

2.1 Introduction                                                          31

2.2 Experimental Section
  2.2.1 Materials and Methodology                                           33
  2.2.2 Characterization Techniques                                         34

2.3 Results and Discussion
  2.3.1 Powder X-ray diffraction analysis                                   36
  2.3.2 Particle size and morphological analysis                           39
  2.3.3 Effect of silicon doping on the optical properties of $Y_6MoO_{12}$ pigments 40
  2.3.4 Effect of praseodymium doping on the optical properties of $Y_6MoO_{12}$ pigments 44
  2.3.5 NIR reflectance of the pigments coated on roofing material         48
(asbestos)

2.3.6 Thermal and chemical stability studies of the pigments 51

2.4 Conclusions 53

Chapter 3  The synthesis and characterization of environmentally benign non-toxic inorganic pigments based on CeO$_2$–TiO$_2$–Pr$_6$O$_{11}$ solid solutions: Surface coating studies

Summary 55

3.1 Introduction 56

3.2 Experimental Section 57

3.2.1 Materials and Methodology 58

3.2.2 Methodology adopted for coloration of plastic materials 58

3.2.3 Characterization Techniques 58

3.3 Results and Discussion 58

3.3.1 Powder X-ray diffraction analysis 58

3.3.2 Particle size and morphological analysis 61

3.3.3 The optical properties of Ce$_{1-(x+y)}$Ti$_x$Pr$_y$O$_2$ pigments 61

3.3.4 Thermal and chemical stability studies 65

3.3.5 Development of paint formulation and evaluation of mass tone/hiding power and tinting strength 66

3.3.6 Weather resistance studies 69

3.3.7 Oil absorption study 70

3.3.8 Applications in coloring of plastics 70

3.4 Conclusions 71

Chapter 4  The synthesis and characterization of alkaline-earth metal doped Pr$_2$Mo$_2$O$_9$ pigments: Applications in coloring of plastics

Summary 73

4.1 Introduction 74

4.2 Experimental Section 75

4.2.1 Materials and Methodology 75

4.2.2 Methodology adopted for coloration of plastic materials 75

4.2.3 Characterization Techniques 75

4.3 Results and Discussion 76

4.3.1 Powder X-ray diffraction analysis 76

4.3.2 Particle size and morphological analysis 80
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3.3</td>
<td>The optical properties of Pr$_2$Mo$_2$O$_9$ pigment</td>
<td>81</td>
</tr>
<tr>
<td>4.3.4</td>
<td>The optical properties of alkaline-earth metal doped Pr$_2$Mo$_2$O$_9$ pigments</td>
<td>82</td>
</tr>
<tr>
<td>4.3.5</td>
<td>Thermal and chemical stability studies of the pigments</td>
<td>87</td>
</tr>
<tr>
<td>4.3.6</td>
<td>Applications in coloring of plastics</td>
<td>89</td>
</tr>
<tr>
<td><strong>4.4</strong></td>
<td><strong>Conclusions</strong></td>
<td>91</td>
</tr>
</tbody>
</table>

**References** 93
