CHAPTER 2: HYDROTHERMAL SYNTHESIS AND CHARACTERIZATION OF ALUMINO-SILICATE SODALITE DOPED WITH MIXED CATIONS AND ANIONS

2.1 Introduction 46
2.2 Experimental 47
2.3 Results and Discussion 49
  2.3.1 IR spectroscopy 49
  2.3.2 X-ray powder diffraction 54
2.4 Synthesis and characterization of Silver Derivatives of Na$_8$[AlSiO$_4$]$_6$(ClO$_4$)$_2$ and Na$_8$[AlSiO$_4$]$_6$(MnO$_4$)$_2$ Sodalite
  2.4.1 IR spectroscopy 60

CHAPTER 3: SYNTHESIS AND CHARACTERIZATION OF ALUMINO-GERMANATE SODALITES

Section A: Hydrothermal Synthesis and Characterization of Alumino-germanate Perchlorate Sodalite and its Silver and Potassium Derivatives

3.1A Introduction 68
3.2A Experimental 69
  3.2.1A Synthesis 69
  3.2.2A Spectroscopy 70
3.3A Results and Discussion 71
  3.3.1A IR spectroscopy 71
  3.3.2A Raman spectroscopy 72
  3.3.3A Structure refinement 76
  3.3.4A MAS NMR spectroscopy 82
  3.3.5A Thermal analysis 87
  3.3.6A Crystal morphology 89
Section B: Synthesis and Characterization of Chlorate and Thiocynate Enclathrated Alumino-germanate Sodalite $\text{Na}_8[\text{AlGeO}_4]_6(X)_2$, where $X=\text{SCN}^-$ and $\text{ClO}_3^-$

3.1B Introduction 91
3.2B Experimental 93
3.3B Results and Discussion 94

| 3.3.1B | IR spectroscopy | 94 |
| 3.3.2B | Structure refinement | 97 |
| 3.3.3B | MAS NMR study | 103 |
| 3.3.4B | Thermal analysis | 106 |
| 3.3.5B | Crystal morphology | 106 |

Section C: Solvothermal Synthesis and Crystal Structure of Alumino-Germanate Halide Sodalites in Organic Solvent

3.1C Introduction 109
3.2C Experimental 110
3.3C Results and Discussion 112

| 3.3.1C | IR spectroscopy | 112 |
| 3.3.2C | Structure refinement | 115 |
| 3.3.3C | MAS NMR spectroscopy | 120 |
| 3.3.4C | Thermal analysis | 123 |
| 3.3.5C | Crystal morphology | 125 |

CHAPTER 4: SYNTHESIS AND CHARACTERIZATION OF ALUMINO-SILICATE SODALITES FROM FLY ASH AND THEIR ENVIRONMENTAL APPLICATIONS

Section A: Coal Fly Ash: The Potential Alumino-Silicate Source: Synthesis and Characterization of Halide Sodalites

4.1A Introduction 129
4.2A Experimental 132
Section B: Chemical Modification of Coal Fly Ash into Iodate Sodalite and It’s Use for the Removal of Cd\textsuperscript{2+}, Pb\textsuperscript{2+} and Zn\textsuperscript{2+} From Their Aqueous Solutions
Section C: Synthesis of Intense Blue Ultramarine: Coal Fly Ash as an Alumino-Silicate Source Under Environment-Friendly Conditions

4.1C Introduction 171
4.2C Materials and Methods 173
   4.2.1C Synthesis 173
   4.2.2C Experimental 177
4.3C Results and Discussion 178
   4.3.1C IR spectroscopy 178
   4.3.2C Raman spectroscopy 179
   4.3.3C UV-Visible diffused reflectance spectrum 180
   4.3.4C ESR spectroscopy 180
   4.3.5C X-ray powder diffraction 183
   4.3.6C Thermal analysis 185
   4.3.7C MAS NMR spectroscopy 185
   4.3.8C Crystal morphology 186

REFERENCES: 191

RESEARCH PUBLICATIONS: 213