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ภาคผนวก

ภาคผนวก ก

การ์ดมาตรฐาน JCPDS

| 37-1484 | | Wavelength= 1.5405981 * | | | | | | | | | |
|--|---------|-------------------------|---|---|---|---------|---------|----|---|---|---|
| ZrO2 | 2θ | Int | h | k | l | 2θ | Int | h | k | l | |
| Zirconium Oxide | 17.419* | 3 | 0 | 0 | 1 | 65.884* | 4 | 1 | 3 | 2 | |
| | 24.048* | 14 | 1 | 1 | 0 | 68.912* | 1 | 2 | 3 | 1 | |
| | 24.441* | 10 | 0 | 1 | 1 | 69.620* | <1 | 3 | 2 | 1 | |
| Baddeleyite, syn | 28.175 | 100 | 1 | 1 | 1 | 70.190* | <1 | 3 | 2 | 2 | |
| Rad.: CuKα1: 1.5405 Filter: Graph Mono&sp: Diffractometer | 31.468* | 68 | 1 | 1 | 1 | 71.071* | 2 | 2 | 2 | 3 | |
| Cut off: 17.7 Int.: Diffract. I/cor.: 2.6 | 34.160* | 21 | 2 | 0 | 0 | 71.300* | 4 | 4 | 0 | 1 | |
| Ref: McMurdie, H et al., Powder Diffraction, 1, 275 (1986) | 34.383* | 11 | 0 | 2 | 0 | 71.950* | 1 | 4 | 0 | 0 | |
| | 35.309* | 13 | 0 | 0 | 2 | 72.104* | 1 | 2 | 3 | 2 | |
| | 35.900* | 2 | 2 | 0 | 1 | 72.450* | <1 | 0 | 4 | 0 | |
| | 38.396 | 1 | [| 2 | 1 | 0] | 72.642* | <1 | 3 | 1 | 2 |
| | 38.541* | 4 | 1 | 2 | 0 | 73.580* | <1 | 3 | 1 | 3 | |
| Sys.: Monoclinic S.G.: P2 ₁ /a (14) | 39.411* | <1 | 0 | 1 | 2 | 74.682* | 2 | 0 | 0 | 4 | |
| a: 5.3129(4) b: 5.2125(4) c: 5.1471(5) A: 1.0193 C: 0.9875 | 39.990* | <1 | 2 | 1 | 1 | 75.046* | 4 | 1 | 4 | 0 | |
| α: β: 99.218(8) γ: Z: 4 mp: | 40.725* | 12 | 1 | 1 | 2 | 76.410* | 1 | 1 | 1 | 4 | |
| Ref: Ibid. | 41.150* | 5 | 2 | 0 | 1 | 77.392* | <1 | 3 | 3 | 0 | |
| | 41.374* | 5 | 1 | 2 | 1 | 78.079* | <1 | 4 | 0 | 1 | |
| | 44.826* | 7 | 2 | 1 | 1 | 78.866* | 1 | 0 | 3 | 3 | |
| | 45.522* | 6 | 2 | 0 | 2 | | | | | | |
| Dx: 5.817 Dm: SS/FOM ₃ β-111(.0073, 37) | 48.949* | 2 | 2 | 1 | 2 | | | | | | |
| | 49.266* | 18 | 2 | 2 | 0 | | | | | | |
| Color: Colorless | 50.116* | 22 | 0 | 2 | 2 | | | | | | |
| Peak height intensity. The mean temperature of the data collection was 25.5°. Sample was obtained from Titanium Alloy Manufacturing Co. (1990) and was heated to 1300° for 48 hours. CAS #: 1314-23-4. Spectrographic analysis showed that this sample contained less than 0.01% each of Al, Hf and Mg and between 0.1 and 0.01% each of Fe, Si and Ti. Pattern reviewed by Holzer, J., McCarthy, G., North Dakota State Univ., Fargo, ND, USA, ICDD Grant-in-Aid (1990). Agrees well with experimental and calculated patterns. Additional weak reflections [indicated by brackets] were observed. α(I _{obs}) = ±1. There are a number of polymorphic forms of Zr O2 stable at different temperatures and pressures. The structure of Zr O2 (baddeleyite) was determined by McCullough and Trueblood (1) and confirmed by Smith and Newkirk (2). O2 Zr type. Also called: zirconium dioxide. Also called: zirkite. Silver, fluorophlogopite used as an internal stands. PSC: mP12. To replace 13-307 and 36-420 and validated by calculated pattern 24-1165. Mwt: 123.22. Volume[CD]: 140.70. | 50.559* | 13 | 2 | 2 | 1 | | | | | | |
| | 51.193* | 5 | 1 | 2 | 2 | | | | | | |
| | 54.104* | 11 | 0 | 0 | 3 | | | | | | |
| | 54.680* | <1 | 2 | 2 | 1 | | | | | | |
| | 55.270 | 11 | [| 1 | 2 | 2] | | | | | |
| | 55.400* | 11 | 3 | 1 | 0 | | | | | | |
| | 55.570* | 9 | 3 | 1 | 1 | | | | | | |
| | 55.883* | 6 | 0 | 3 | 1 | | | | | | |
| | 57.168* | 7 | 1 | 1 | 3 | | | | | | |
| | 57.861* | 4 | 1 | 3 | 1 | | | | | | |
| | 58.268* | 3 | 2 | 2 | 2 | | | | | | |
| | 59.775* | 8 | 1 | 3 | 1 | | | | | | |
| | 60.055* | 7 | 2 | 0 | 3 | | | | | | |
| | 61.367* | 5 | 3 | 1 | 1 | | | | | | |
| | 61.984* | 5 | 3 | 1 | 2 | | | | | | |
| | 62.838* | 8 | 1 | 1 | 3 | | | | | | |
| | 64.079* | 1 | 3 | 2 | 0 | | | | | | |
| | 64.250* | 2 | 2 | 3 | 0 | | | | | | |
| | 64.966* | <1 | 0 | 3 | 2 | | | | | | |
| | 65.384* | 2 | 2 | 3 | 1 | | | | | | |
| | 65.700* | 6 | 0 | 2 | 3 | | | | | | |

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| 04-0477 | | Wavelength= 1.54056 i | | | | | | | | | |
|--|---------|-----------------------|---|---|----|---------|-----|---|---|---|--|
| TiO2 | 2θ | Int | h | k | l | 2θ | Int | h | k | l | |
| Titanium Oxide | 25.354 | 100 | 1 | 0 | 1 | 120.391 | 2 | 2 | 2 | 8 | |
| | 36.883* | 9 | 1 | 0 | 3 | 135.889 | <1 | 3 | 2 | 7 | |
| | 37.784* | 22 | 0 | 0 | 4 | 137.384 | 3 | 4 | 1 | 5 | |
| Anatase, syn | 38.506* | 9 | 1 | 1 | 2 | 143.965 | 1 | 3 | 0 | 9 | |
| Rad.: CuKα1: 1.5405 Filter: Ni Beta□M d-sp: Diffractometer | 48.076* | 33 | 2 | 0 | 0 | 149.183 | 3 | | | | |
| Cut off: Int.: Diffract. I/cor.: | 53.921* | 21 | 1 | 0 | 5 | | | | | | |
| Ref: Swanson, Tatge, Private Communication, (1950) | 55.114* | 19 | 2 | 1 | 1 | | | | | | |
| | 62.073* | 4 | 2 | 1 | 3 | | | | | | |
| | 62.726* | 13 | 2 | 0 | 4 | | | | | | |
| | 68.594* | 5 | 1 | 1 | 6 | | | | | | |
| | 70.357* | 5 | 2 | 2 | 0 | | | | | | |
| Sys.: Tetragonal S.G.: I4 ₁ /amd (141) | 75.092* | 10 | 2 | 1 | 5 | | | | | | |
| a: 3.783 b: c: 9.51 A: C: 2.5139 | 76.082* | 3 | 3 | 0 | 1 | | | | | | |
| α: β: γ: Z: 4 mp: | 82.264* | 2 | 3 | 0 | 3 | | | | | | |
| Ref: Ibid. | 83.138* | 3 | 3 | 1 | 2 | | | | | | |
| | 90.258* | 3 | | | | | | | | | |
| | 95.176* | 3 | 3 | 2 | 1 | | | | | | |
| | 98.433* | 2 | 1 | 0 | 9 | | | | | | |
| Dx: 3.899 Dm: SS/FOM ₂ β-8(.062, 48) | 107.525 | 4 | 3 | 1 | 6 | | | | | | |
| | 109.009 | 3 | 4 | 0 | 0 | | | | | | |
| | 113.914 | 2 | 3 | 2 | 5 | | | | | | |
| PSC: t112. Mwt: 79.90. Volume[CD]: 136.10. | 118.563 | 3 | 1 | 1 | 10 | | | | | | |

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| 05-0570 | | Wavelength= 1.5405 * | | | | | | | | | |
|--|--|----------------------|-----|---|---|---|------------|-----|---|---|---|
| PbO | | 2 θ | Int | h | k | l | 2 θ | Int | h | k | l |
| Lead Oxide | | 15.021* | 6 | 0 | 0 | 1 | 80.836* | 3 | 4 | 2 | 0 |
| | | 29.090 | 100 | 1 | 1 | 1 | 82.005* | 4 | 3 | 3 | 1 |
| | | 30.313* | 31 | 0 | 0 | 2 | 85.103* | 2 | 2 | 2 | 4 |
| Masicot, syn | | 32.604* | 28 | 2 | 0 | 0 | 86.900* | 2 | 1 | 1 | 5 |
| Rad.: CuK α 1: 1.5405 Filter: Ni Beta DM d-sp: | | 35.994* | <1 | 2 | 0 | 1 | 88.687* | 4 | 4 | 2 | 2 |
| Cut off: Int: Diffract. I/cor.: 6.60 | | 37.815* | 20 | 2 | 1 | 0 | 89.821* | 2 | 2 | 4 | 0 |
| Ref: Swanson, Fuyat, Natl. Bur. Stand. (U.S.), Circ. 539, 2, 32 (1953) | | 39.525* | <1 | 1 | 1 | 2 | | | | | |
| | | 40.930* | <1 | 2 | 1 | 1 | | | | | |
| | | 45.113* | 12 | 2 | 0 | 2 | | | | | |
| | | 46.206* | 2 | 0 | 0 | 3 | | | | | |
| | | 49.209* | 14 | 0 | 2 | 2 | | | | | |
| Sys.: Orthorhombic S.G.: Pbrma (57) | | 50.761* | 14 | 2 | 2 | 0 | | | | | |
| a: 5.489 b: 4.755 c: 5.891 A: 1.1544 C: 1.2389 | | 53.075* | 15 | 1 | 1 | 3 | | | | | |
| α : β : γ : Z: 4 mp: | | 56.025* | 13 | 3 | 1 | 1 | | | | | |
| Ref: Kay, Acta Crystallogr., 14, 80 (1961) | | 57.712* | <1 | 2 | 0 | 3 | | | | | |
| | | 60.281* | 9 | 2 | 2 | 2 | | | | | |
| | | 61.161* | 2 | 0 | 2 | 3 | | | | | |
| | | 63.008* | 11 | 1 | 3 | 1 | | | | | |
| Dx: 9.642 Dm: 9.642 SS/FOM β -29(.0157, 66) | | 66.330* | <1 | 3 | 2 | 1 | | | | | |
| | | 68.306* | 1 | 4 | 0 | 0 | | | | | |
| Color: Yellow | | 68.820* | <1 | 1 | 1 | 4 | | | | | |
| X-ray pattern at 27 C. Sample from National Lead | | 71.087* | 1 | 2 | 2 | 3 | | | | | |
| Company, CAS #: 1317-36-8. Spectroscopic analysis: | | 72.864* | 2 | 2 | 0 | 4 | | | | | |
| <0.01% Bi, Fe; <0.001% Al, Ag, Cu, Mg, Si, Ca. Other | | 73.390* | 3 | 3 | 1 | 3 | | | | | |
| form, litharge. O Pb type. C.D. Cell: a=5.489, b=5.891, | | 75.935* | 2 | 0 | 2 | 4 | | | | | |
| c=4.755, a/b=0.9318, c/b=0.8072, S.G.=Pcam(57). PSC: oP8. | | 76.511* | 2 | 2 | 3 | 2 | | | | | |
| Deleted by 38-1477. Mwt: 223.20. Volume[CD]: 153.76. | | 79.625* | 4 | 1 | 3 | 3 | | | | | |

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| 33-0784 | | Wavelength= 1.5418 | | | | | | | | | |
|--|--|--------------------|-----|---|---|---|------------|-----|---|---|---|
| Pb(Zr _{0.52} Ti _{0.48})O ₃ | | 2 θ | Int | h | k | l | 2 θ | Int | h | k | l |
| Lead Zirconium Titanium Oxide | | 21.432* | 9 | 0 | 0 | 1 | 78.379* | 2 | 3 | 1 | 1 |
| | | 22.023* | 12 | 1 | 0 | 0 | 85.099* | 4 | 2 | 0 | 3 |
| | | 30.942 | 100 | 1 | 0 | 1 | 86.034* | 4 | 3 | 0 | 2 |
| | | 31.387 | 100 | 1 | 1 | 0 | 86.992* | 4 | 3 | 2 | 0 |
| Rad.: CuK α 1: 1.5418 Filter: Ni Beta DM d-sp: Diffractometer | | 38.283* | 15 | 1 | 1 | 1 | 88.985* | 15 | 1 | 2 | 3 |
| Cut off: Int: Diffract. I/cor.: | | 43.663* | 9 | 0 | 0 | 2 | 90.023* | 15 | 3 | 2 | 1 |
| Ref: Kakegawa, K. et al., Solid State Commun., 24, 769 (1977) | | 44.917* | 16 | 2 | 0 | 0 | 91.089* | 15 | 3 | 2 | 1 |
| | | 49.424* | 5 | 1 | 0 | 2 | 96.092* | <1 | 0 | 0 | 4 |
| | | 50.417* | 6 | 2 | 0 | 1 | 99.627* | <1 | 4 | 0 | 0 |
| | | 50.417* | 6 | 2 | 1 | 0 | 100.319 | <1 | 1 | 0 | 4 |
| | | 53.390* | 5 | | | | 101.881 | <1 | 2 | 2 | 3 |
| Sys.: Tetragonal S.G.: | | 54.734* | 12 | 1 | 1 | 2 | 102.991 | 1 | 3 | 2 | 2 |
| a: 4.036 b: c: 4.146 A: C: 1.0273 | | 55.524* | 24 | 2 | 1 | 1 | 104.602 | 2 | 1 | 1 | 4 |
| α : β : γ : Z: 1 mp: | | 64.434* | 9 | 0 | 2 | 2 | 106.185 | 2 | 3 | 0 | 3 |
| Ref: Ibid. | | 65.398* | 5 | 2 | 2 | 0 | 107.981 | 4 | 4 | 1 | 1 |
| | | 67.810* | 2 | 0 | 0 | 3 | 108.313 | 4 | 3 | 3 | 0 |
| | | 69.002* | 6 | 2 | 1 | 2 | 110.595 | 1 | 1 | 3 | 3 |
| | | 69.645* | 6 | 2 | 2 | 1 | 112.473 | <1 | 3 | 3 | 1 |
| Dx: 8.006 Dm: SS/FOM β -15(.060, 34) | | 69.645* | 6 | 3 | 0 | 0 | 113.446 | 2 | 2 | 0 | 4 |
| | | 72.225* | 6 | 1 | 0 | 3 | 116.411 | 6 | 4 | 0 | 2 |
| Color: Light yellow | | 74.065* | 9 | 3 | 0 | 1 | 117.235 | 6 | 4 | 2 | 0 |
| No composition fluctuation. Silicon used as an internal | | 74.065* | 9 | 3 | 1 | 0 | 118.076 | 6 | 1 | 2 | 4 |
| stand. Mwt: 325.62. Volume[CD]: 67.54. | | 76.588* | 2 | 1 | 1 | 3 | 121.167 | 1 | 4 | 1 | 2 |

| 2 θ | Int | h | k | l |
|------------|-----|---|---|---|
| 121.862 | 1 | 4 | 2 | 1 |
| 124.798 | 3 | 2 | 3 | 3 |
| 126.131 | 2 | 3 | 3 | 2 |
| 133.607 | 1 | 2 | 2 | 4 |
| 136.843 | 5 | 0 | 0 | 5 |
| 137.195 | 5 | 4 | 2 | 2 |
| 139.685 | 2 | 3 | 0 | 4 |

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| 42-1650 | | Wavelength= 1.5418 * | | | | | | | | | |
|--|--|----------------------|-----|---|---|---|------------|-----|---|---|---|
| (C2H2F2)n | | 2 θ | Int | h | k | l | 2 θ | Int | h | k | l |
| Polyvinylidene fluoride | | 17.883*34 | 1 | 0 | 0 | | 50.807*14 | 1 | 5 | 0 | |
| | | 18.407*41 | 0 | 2 | 0 | | 52.132*16 | 1 | 3 | 2 | |
| | | 20.135*00 | 1 | 1 | 0 | | 52.980*1 | 2 | 4 | 0 | |
| | | 25.773*22 | 1 | 2 | 0 | | 54.268*14 | 2 | 0 | 2 | |
| | | 26.728*5 | 0 | 2 | 1 | | 54.812*13 | 1 | 5 | 1 | |
| Rad.: CuK α λ : 1.5418 Filter: Ni Beta DM d-sp: Calculated | | 27.967*17 | 1 | 1 | 1 | | 55.586*30 | 3 | 0 | 0 | |
| Cut off: Int: I/cor.: | | 32.346*18 | 1 | 2 | 1 | | 56.470*30 | 3 | 1 | 0 | |
| Ref: Hasegawa, R et al., Polym. J., 3, 600 (1972) | | 33.220*23 | 1 | 3 | 0 | | 56.877*25 | 2 | 4 | 1 | |
| | | 33.983*3 | 0 | 3 | 1 | | 57.801*7 | 2 | 2 | 2 | |
| | | 36.221*30 | 2 | 0 | 0 | | 58.378*7 | 1 | 4 | 2 | |
| | | 37.311*23 | 0 | 4 | 0 | | 59.067*4 | 3 | 2 | 0 | |
| Sys.: Monoclinic S.G.: P2 ₁ /c (14) | | 37.443*23 | 2 | 1 | 0 | | 60.215*12 | 3 | 1 | 1 | |
| a: 4.96 b: 9.64 c: 4.62 A: 0.5145 C: 0.4793 | | 38.657*27 | 1 | 3 | 1 | | 60.577*8 | 1 | 6 | 0 | |
| α : β : 90.0 γ : Z: mp: | | 40.924*1 | 2 | 2 | 0 | | 60.858*8 | 2 | 5 | 0 | |
| Ref: Ibid. | | 41.664*1 | 1 | 4 | 0 | | 61.062*8 | 0 | 6 | 1 | |
| | | 42.295*12 | 0 | 4 | 1 | | 62.036*1 | 2 | 3 | 2 | |
| | | 42.416*12 | 2 | 1 | 1 | | 62.721*2 | 3 | 2 | 1 | |
| | | 43.203*7 | 1 | 0 | 2 | | 64.180*2 | 1 | 6 | 1 | |
| Dx: Dm: SS/FOM ₃ β -1000(0.0005, 38) | | 43.440*7 | 0 | 2 | 2 | | 65.844*13 | 1 | 5 | 2 | |
| | | 44.262*11 | 1 | 1 | 2 | | 66.774*4 | 3 | 3 | 1 | |
| | | 45.582*26 | 2 | 2 | 1 | | 68.864*1 | 3 | 4 | 0 | |
| | | 46.240*4 | 2 | 3 | 0 | | 69.740*1 | 2 | 6 | 0 | |
| Form II D-values calculated using cell parameters reported in reference. Aluminum. PSC: mP?. Mwt: 64.03. Volume[CD]: 220.90. | | 47.330*8 | 1 | 2 | 2 | | 69.972*10 | 3 | 0 | 2 | |
| | | 50.509*4 | 2 | 3 | 1 | | 70.750*10 | 3 | 1 | 2 | |

| 2 θ | Int | h | k | l |
|------------|-----|---|---|---|
| 71.039* | 5 | 1 | 7 | 0 |
| 71.479* | 9 | 0 | 7 | 1 |
| 72.251* | 9 | 3 | 4 | 1 |
| 73.067* | 3 | 3 | 2 | 2 |
| 73.106* | 9 | 2 | 6 | 1 |
| 74.377* | 9 | 1 | 7 | 1 |
| 76.880* | 5 | 4 | 0 | 0 |
| 77.629* | 5 | 4 | 1 | 0 |
| 79.059* | 5 | 3 | 5 | 1 |
| 79.547* | 16 | 0 | 8 | 0 |
| 79.626* | 16 | 2 | 7 | 0 |
| 79.873* | 16 | 4 | 2 | 0 |
| 80.877* | 3 | 4 | 1 | 1 |
| 82.775* | 3 | 0 | 8 | 1 |
| 82.853* | 3 | 2 | 7 | 1 |
| 85.554* | 10 | 1 | 8 | 1 |
| 86.779* | 10 | 4 | 3 | 1 |
| 87.187* | 10 | 3 | 6 | 1 |
| 89.761* | 7 | 4 | 0 | 2 |
| 90.488* | 7 | 4 | 1 | 2 |
| 90.681* | 8 | 2 | 8 | 0 |
| 91.909* | 5 | 4 | 4 | 1 |
| 92.365* | 7 | 0 | 8 | 2 |
| 92.443* | 7 | 2 | 7 | 2 |
| 93.522* | 5 | 3 | 7 | 0 |
| 94.833* | 5 | 1 | 9 | 0 |
| 95.325* | 5 | 4 | 5 | 0 |

ประวัติผู้วิจัย

นางสาวปิยาลักษณ์ เงินชุกลิ่น เกิดวันที่ 23 ตุลาคม พ.ศ.2517 ที่กรุงเทพมหานคร สำเร็จการศึกษาปริญญาตรีวิทยาศาสตร์บัณฑิต ภาควิชาวัสดุศาสตร์ คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย เมื่อปีการศึกษา 2540 เข้าศึกษาต่อในหลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาเทคโนโลยีเซรามิก จุฬาลงกรณ์มหาวิทยาลัย ในปีการศึกษา 2541 สำเร็จการศึกษาในภาคการศึกษาต้น ปีการศึกษา 2543

