Table S1 Most commonly used mechanism functions for the solid-state reactions

|  |  |  |  |
| --- | --- | --- | --- |
| Symbol | Mechanism | G(α) | *f* (α) |
| Reaction order |
| O1 | First-order, n=1 | -ln(1-α) | 1-α |
| O2 | Second-order, n=2 | (1-α)-1-1 | (1-α)2 |
| O3 | Third-order, n=3 | [(1-α)-2-1]/2 | (1-α)3 |
|  |  |  |  |
| Power law |
| P2 | n=1/2 | α1/2 | 2α1/2 |
| P3 | n=1/3 | α1/3 | 3α2/3 |
| P4 | n=1/4 | α1/4 | 4α3/4 |
|  |  |  |  |
| Random nucleation and growth |
| A1.5 | Avrami-Erofeev equation (n=2/3) | [-ln(1-α)]2/3 | 1.5(1-α)[-ln(1-α)]1/3 |
| A2 | Avrami-Erofeev equation (n=1/2) | [-ln(1-α)]1/2 | 2(1-α)[-ln(1-α)]1/2 |
| A3 | Avrami-Erofeev equation (n=1/3) | [-ln(1-α)]1/3 | 3(1-α)[-ln(1-α)]2/3 |
|  |  |  |  |
| Phase boundary reaction |
| R2 | Shrink cylindrical model (n=1/2) | 1-(1-α)1/2 | 2(1-α)1/2 |
| R3 | Shrink cylindrical model (n=1/3) | 1-(1-α)1/3 | 3(1-α)2/3 |
|  |  |  |  |
| Diffusion |
| D1 | One-way transport | α/2 | α2 |
| D2 | Two-way transport (Valensi equation) | α+(1-α)ln(1-α) | [-ln(1-α)]-1 |
| D3 | Three-way transport (Jander equation) | [1-(1-α)1/3]2 | 1.5(1-α)2/3[1-(1-α)1/3]-1 |
| D4 | Three-way transport (G-B equation) | 1-2α/3-(1-α)2/3 | 1.5[(1-α)-1/3-1]-1 |

Table S2 Curve fitting results at different conversion rates

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Smaple | Conversion rate *α* | Fitting curve | R2 | Activation energy *E* (kJ/mol) |
| NS0-Stage1(FWO) | 0.1 | y=-1812.0286x+4.9439 | 0.9561 | 32.9871 |
| 0.2 | y=-1769.1965x+4.7104 | 0.9436 | 32.2074 |
| 0.3 | y=-1583.1499x+4.0599 | 0.9627 | 28.8205 |
| 0.4 | y=-1396.4284x+3.4126 | 0.9767 | 25.4213 |
| 0.5 | y=-1411.1063x+3.3060 | 0.9795 | 25.6885 |
| 0.6 | y=-1667.8883x+3.7994 | 0.9691 | 30.3631 |
| 0.7 | y=-2030.7464x+4.4835 | 0.9615 | 36.9687 |
| 0.8 | y=-2611.5778x+5.5832 | 0.9321 | 47.5425 |
| 0.9 | y=-3190.3003x+6.5346 | 0.9059 | 58.0779 |
| NS0-Stage1(KAS) | 0.1 | y=-3516.4925x-2.2029 | 0.9826 | 29.2361 |
| 0.2 | y=-3404.9763x-2.7798 | 0.9795 | 28.3089 |
| 0.3 | y=-2961.8757x-4.3212 | 0.9961 | 24.6251 |
| 0.4 | y=-2512.4651x-5.8682 | 0.9997 | 20.8886 |
| 0.5 | y=-2516.7884x-6.1956 | 0.9985 | 20.9246 |
| 0.6 | y=-3072.1001x-5.1549 | 0.9999 | 25.5414 |
| 0.7 | y=-3868.3922x-3.6789 | 0.9999 | 32.1618 |
| 0.8 | y=-5163.0761x-1.2498 | 0.9958 | 42.9258 |
| 0.9 | y=-6448.5864x+0.8334 | 0.9899 | 53.6135 |
| NS0-Stage2(FWO) | 0.1 | y=-11044.1067x+11.5757 | 0.9989 | 201.0526 |
| 0.2 | y=-10133.9829x+10.3143 | 0.9993 | 184.4842 |
| 0.3 | y=-10251.4497x+10.2922 | 0.9991 | 186.6226 |
| 0.4 | y=-10274.2965x+10.2077 | 0.9991 | 187.0385 |
| 0.5 | y=-10302.7201x+10.1475 | 0.9994 | 187.5559 |
| 0.6 | y=-10322.0776x+10.0871 | 0.9992 | 187.9084 |
| 0.7 | y=-10340.1179x+10.0294 | 0.9981 | 188.2368 |
| 0.8 | y=-10346.1695x+9.9575 | 0.9948 | 188.3469 |
| 0.9 | y=-10248.4484x+9.7639 | 0.9941 | 186.5679 |
| NS0-Stage2(KAS) | 0.1 | y=-23608.4442x+11.0251 | 0.9957 | 196.2806 |
| 0.2 | y=-21468.3118x+8.0726 | 0.9941 | 178.4875 |
| 0.3 | y=-21714.3118x+7.9953 | 0.9934 | 180.5328 |
| 0.4 | y=-21747.7214x+7.7807 | 0.9931 | 180.8106 |
| 0.5 | y=-21796.9013x+7.6251 | 0.9915 | 181.2194 |
| 0.6 | y=-21827.0126x+7.4711 | 0.9975 | 181.4698 |
| 0.7 | y=-21854.9262x+7.3242 | 0.9829 | 181.7019 |
| 0.8 | y=-21854.9710x+7.1444 | 0.9961 | 181.7022 |
| 0.9 | y=-21613.2537x+6.6819 | 0.9796 | 179.6925 |
| NS1-Stage1(FWO) | 0.1 | y=-2682.1489x+7.5459 | 0.99024 | 48.8272 |
| 0.2 | y=-2973.5099x+8.2178 | 0.99535 | 54.1313 |
| 0.3 | y=-2723.1624x+7.3036 | 0.98692 | 49.5738 |
| 0.4 | y=-2048.4689x+5.2069 | 0.99537 | 37.2914 |
| 0.5 | y=-1372.9183x+3.1862 | 0.93994 | 24.9933 |
| 0.6 | y=-1160.9863x+2.4799 | 0.96487 | 21.1352 |
| 0.7 | y=-1401.3619x+2.9175 | 0.95527 | 25.5111 |
| 0.8 | y=-1855.3896x+3.7714 | 0.99994 | 33.7765 |
| 0.9 | y=-2301.7408x+4.4689 | 0.95925 | 41.9021 |
| NS1-Stage1(KAS) | 0.1 | y=-5505.9605x+3.7468 | 0.98905 | 45.7765 |
| 0.2 | y=-6161.8374x+5.2495 | 0.99476 | 51.2295 |
| 0.3 | y=-5568.9682x+3.0971 | 0.98497 | 46.3004 |
| 0.4 | y=-3994.8918x-1.7888 | 0.99896 | 33.2135 |
| 0.5 | y=-2414.6481x-6.5092 | 0.92783 | 20.0754 |
| 0.6 | y=-1894.2226x-8.2207 | 0.90347 | 15.7486 |
| 0.7 | y=-2404.5301x-7.3209 | 0.93601 | 19.9913 |
| 0.8 | y=-3398.1979x-5.4769 | 0.93204 | 28.2526 |
| 0.9 | y=-4366.1094x-4.0034 | 0.98967 | 36.2998 |
| NS1-Stage2(FWO) | 0.1 | y=-9437.7106x+10.053 | 0.9954 | 171.8089 |
| 0.2 | y=-12073.2761x+12.4235 | 0.9959 | 219.7881 |
| 0.3 | y=-14104.6215x+14.3258 | 0.9898 | 256.7677 |
| 0.4 | y=-15314.8078x+15.4105 | 0.9939 | 278.7986 |
| 0.5 | y=-15742.8988x+15.6855 | 0.9952 | 286.5917 |
| 0.6 | y=-15912.6818x+15.7204 | 0.9956 | 289.6826 |
| 0.7 | y=-16116.4931x+15.7976 | 0.9962 | 293.3928 |
| 0.8 | y=-16357.3598x+15.9096 | 0.9968 | 297.7777 |
| 0.9 | y=-16591.4402x+15.9896 | 0.9982 | 302.0391 |
| NS1-Stage2(KAS) | 0.1 | y=-19951.9523x+7.5661 | 0.9706 | 215.6598 |
| 0.2 | y=-25939.3546x+12.9351 | 0.9571 | 254.2596 |
| 0.3 | y=-30582.1044x+17.2875 | 0.9401 | 277.2255 |
| 0.4 | y=-33344.4186x+19.7301 | 0.9519 | 285.2605 |
| 0.5 | y=-34310.8603x+20.3641 | 0.9561 | 288.3715 |
| 0.6 | y=-34685.0540x+20.4271 | 0.9572 | 292.1421 |
| 0.7 | y=-35138.5775x+20.5889 | 0.9595 | 296.6209 |
| 0.8 | y=-35677.2872x+20.8308 | 0.9615 | 300.9447 |
| 0.9 | y=-36197.3491x+20.9958 | 0.9673 | 165.8805 |