Supporting Information

The Wax-Liquid Transition Modulates Hydrocarbon Respiration Rates in *Alcanivorax borkumensis* SK2

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Figures

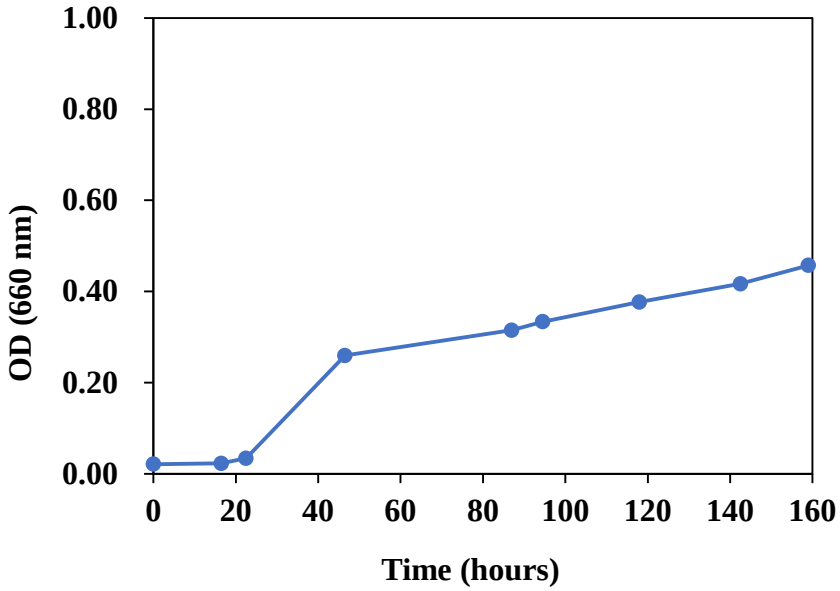

Figure S1. Typical growth pattern for *A. borkumensis* SK2 on hexadecane in ONR7a medium at 30ºC at 150 rpm.

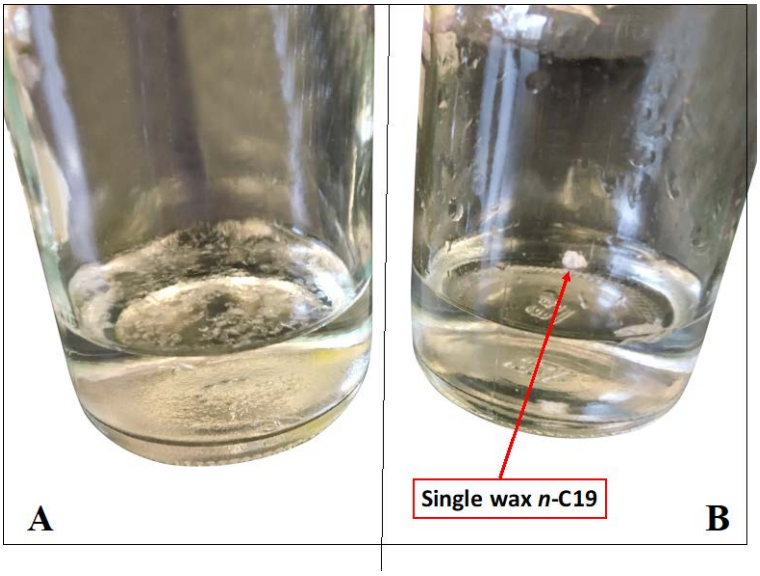

Figure S2. Size of wax *n*-C_{19} at the onset of the second experiment. (A) Microparticles (B) Single particle

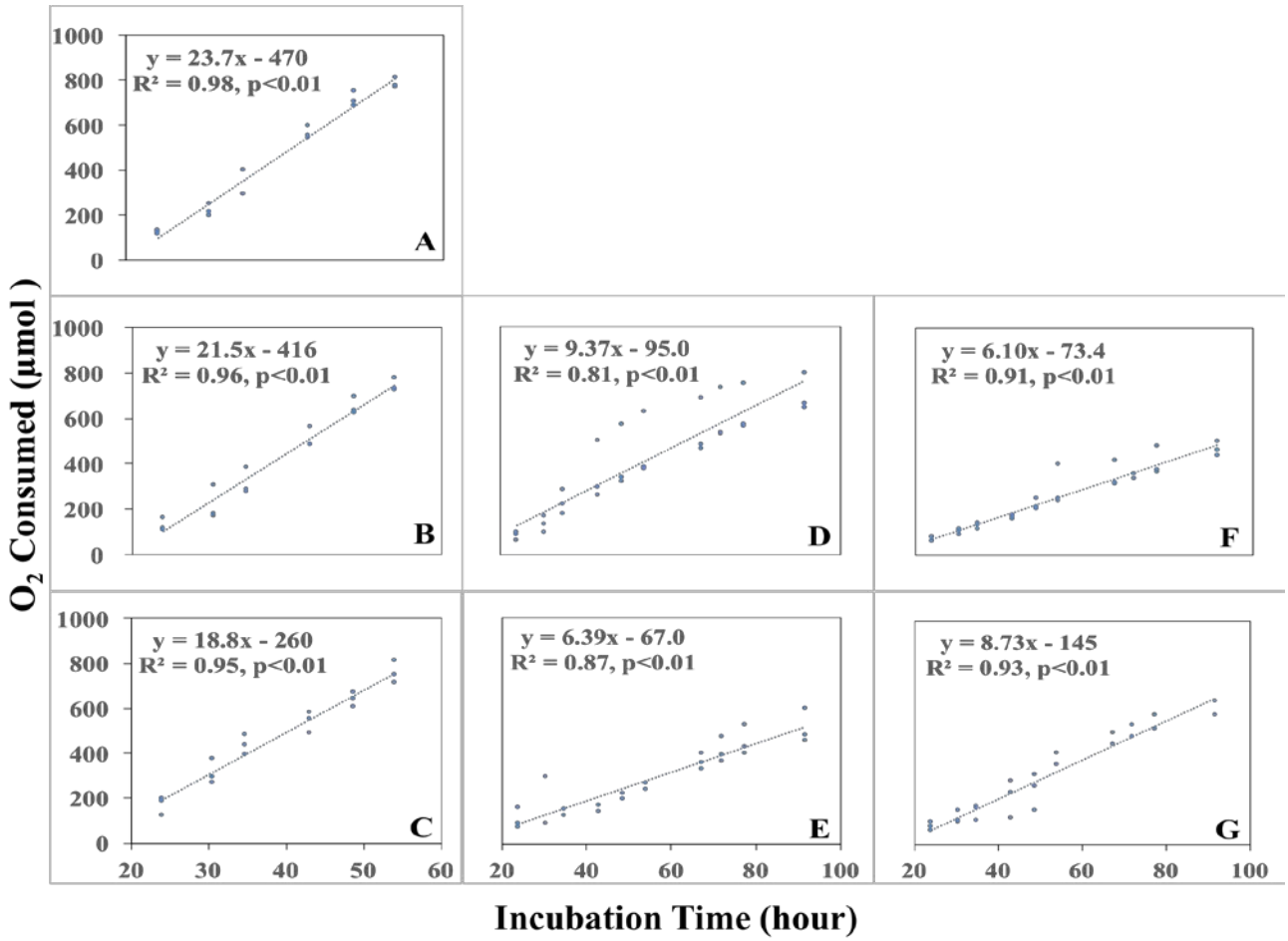

Figure S3. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 20ºC using the three replicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15} and *n*-C_{16} are in the form of liquid; *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20} are in the form of wax.

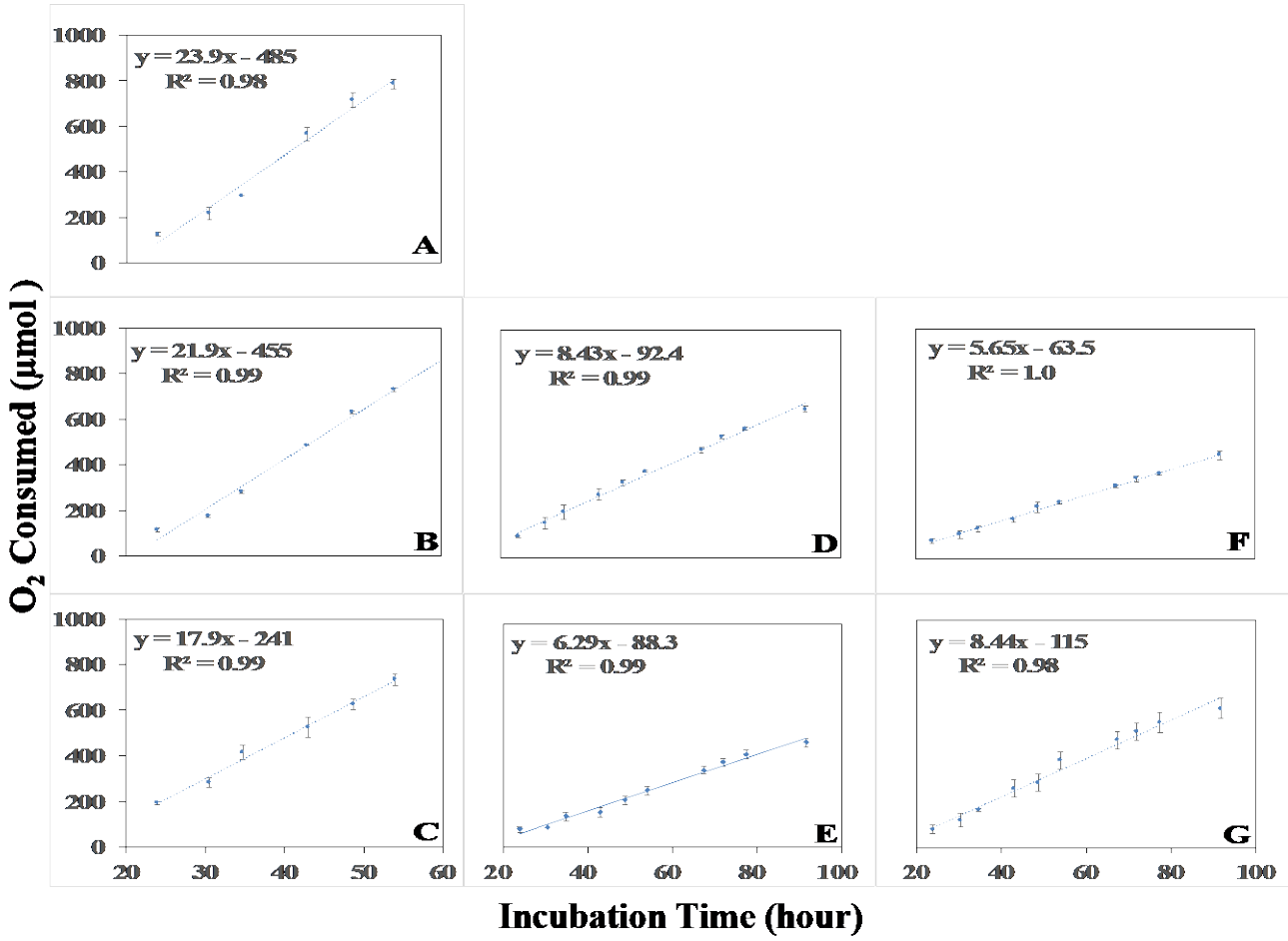

Figure S4. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 20ºC using the mean value of three triplicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15} and *n*-C_{16} are in the form of liquid; *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20} are in the form of wax.

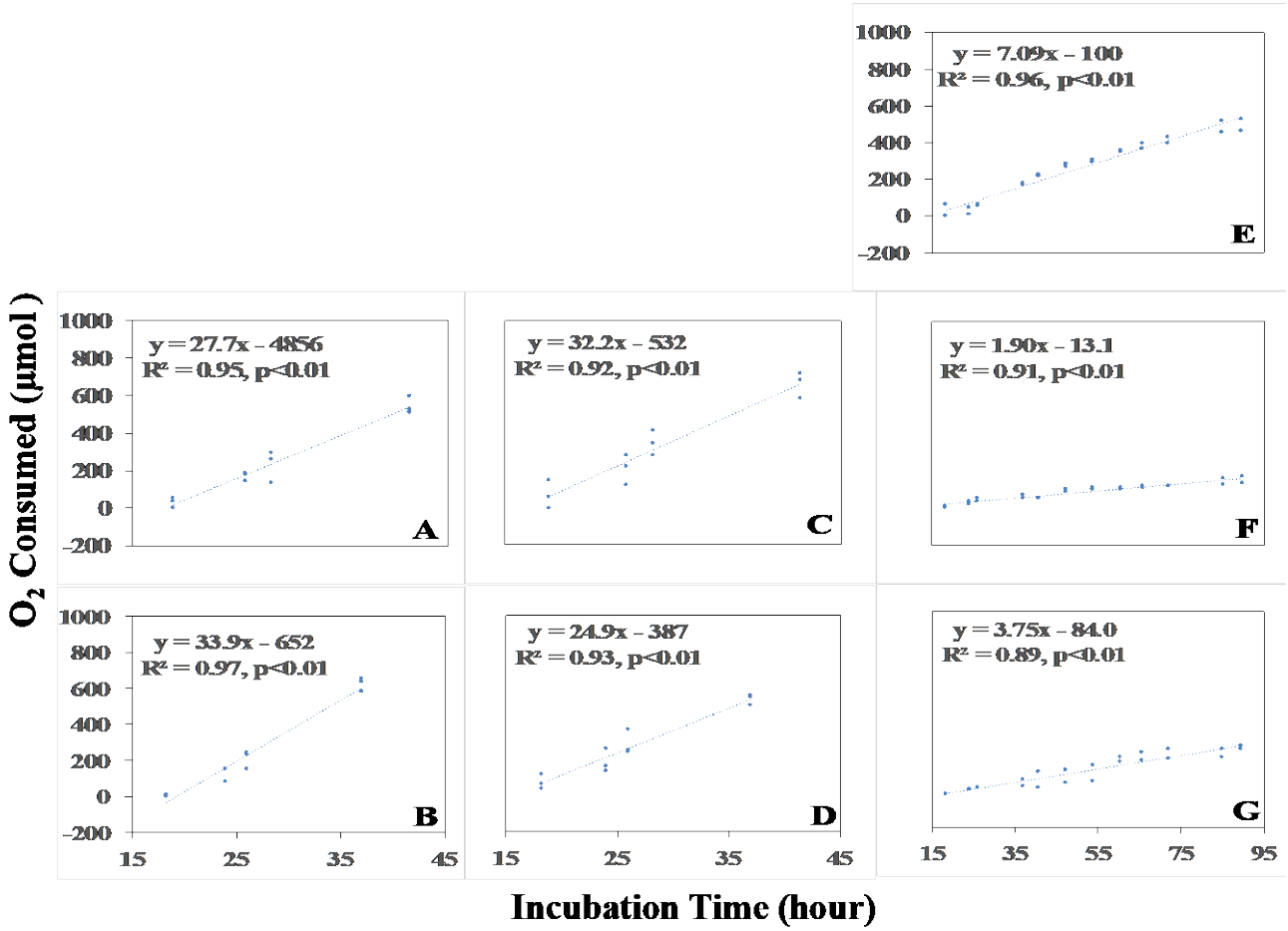

Figure S5. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 25ºC using the three replicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15}, *n*-C_{16} and *n*-C_{17} are in the form of liquid; *n*-C_{18}, *n*-C_{19} and *n*-C_{20} are in the form of wax.

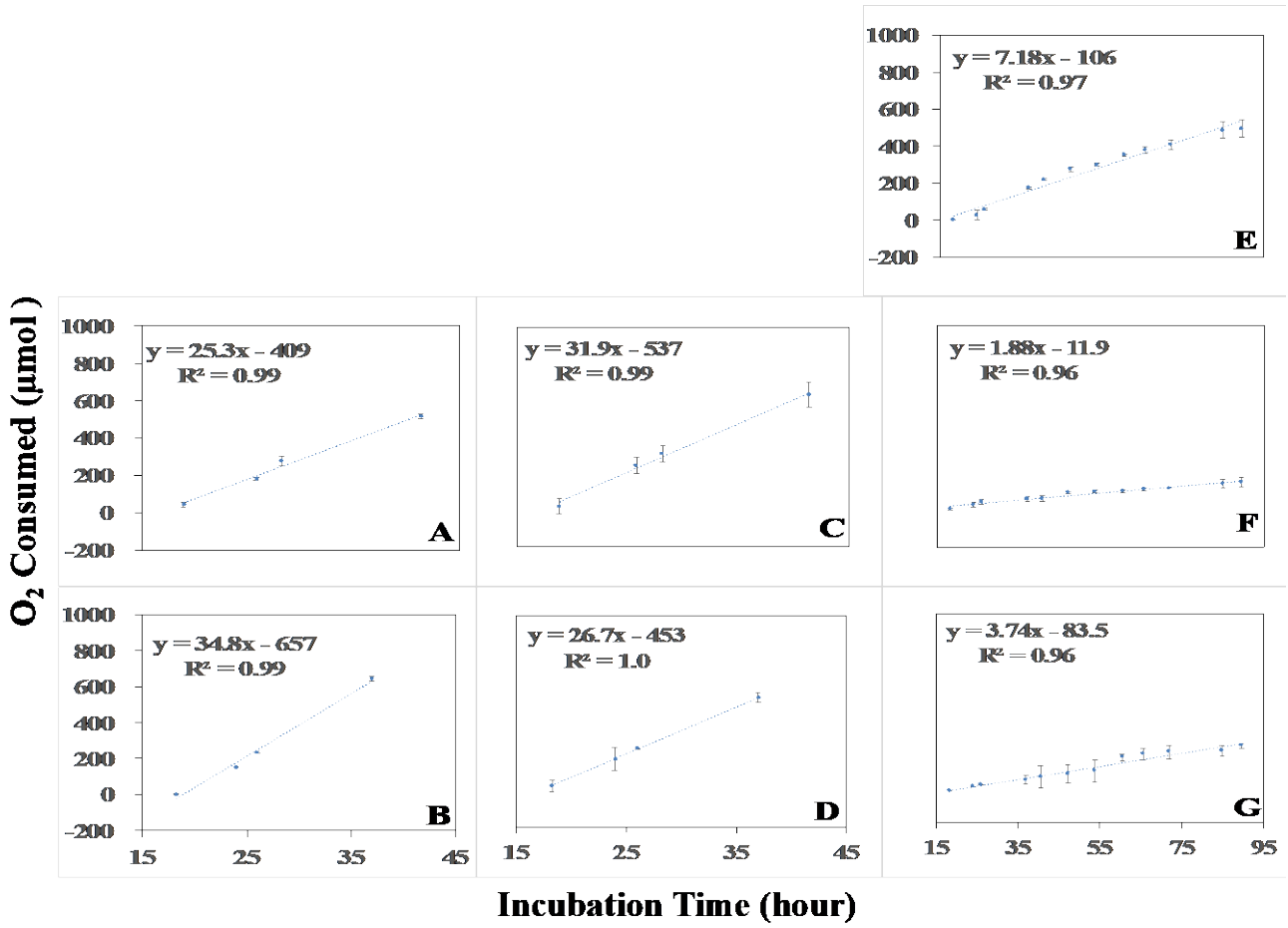

Figure S6. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 25ºC using the mean value of three triplicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15}, *n*-C_{16} and *n*-C_{17} are in the form of liquid; *n*-C_{18}, *n*-C_{19} and *n*-C_{20} are in the form of wax.

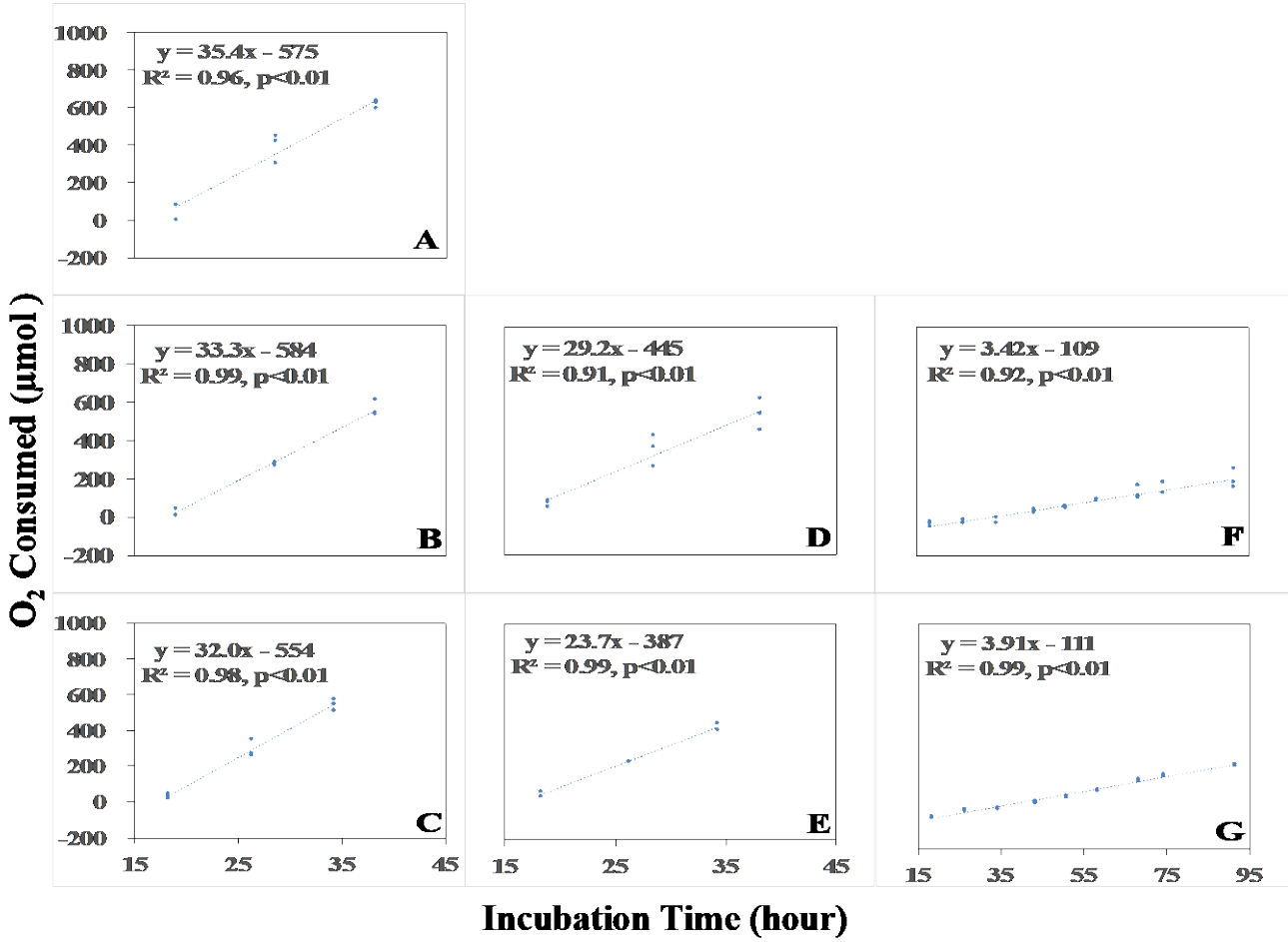

Figure S7. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 30ºC using the three replicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17} and *n*-C_{18} are in the form of liquid; *n*-C_{19} and *n*-C_{20} are in the form of wax.

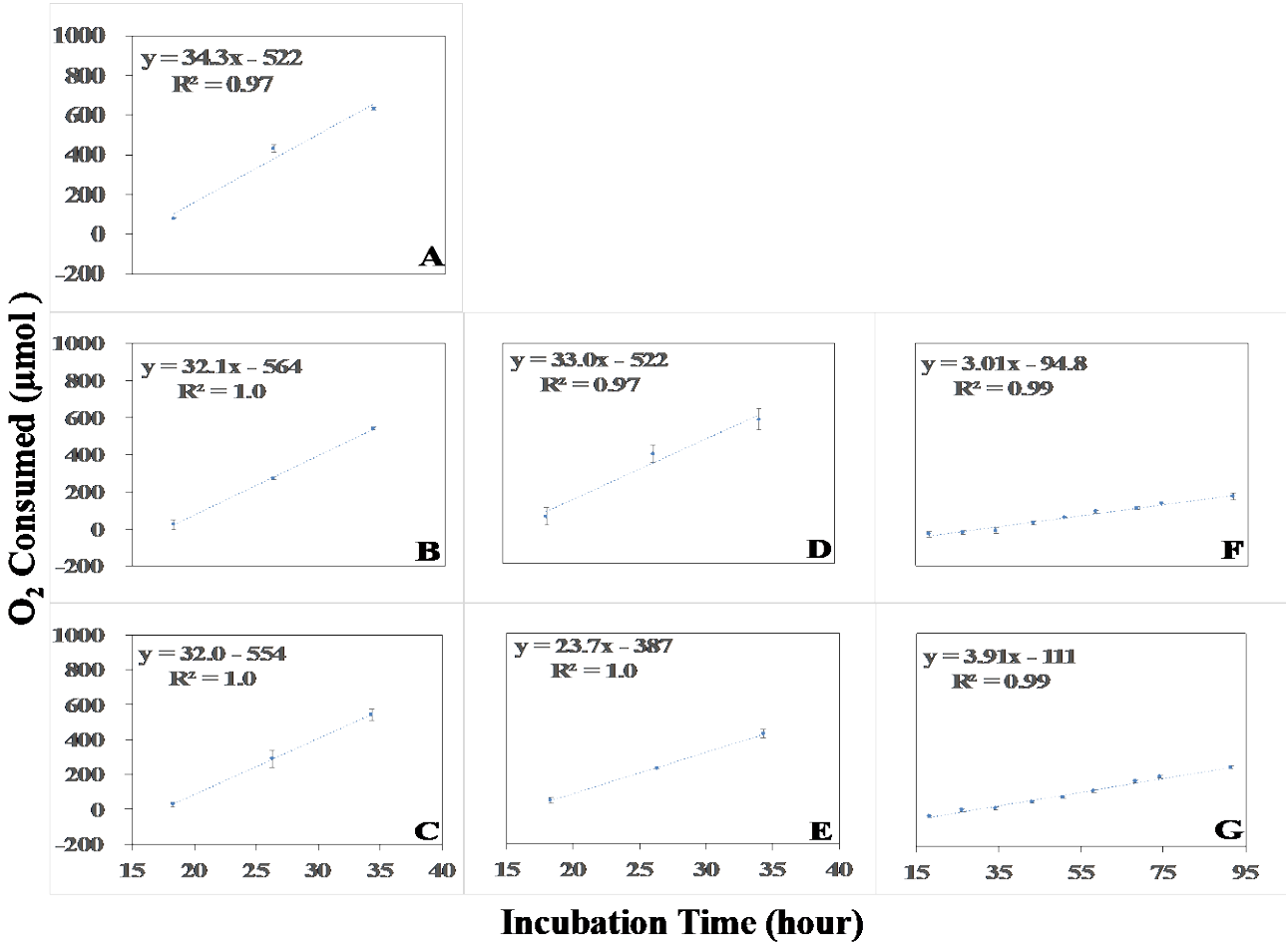

Figure S8. Linear regressions for the respiration rate of *A. borkumensis* SK2 on various alkanes at 30ºC using the mean value of three triplicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17} and *n*-C_{18} are in the form of liquid; *n*-C_{19} and *n*-C_{20} are in the form of wax.

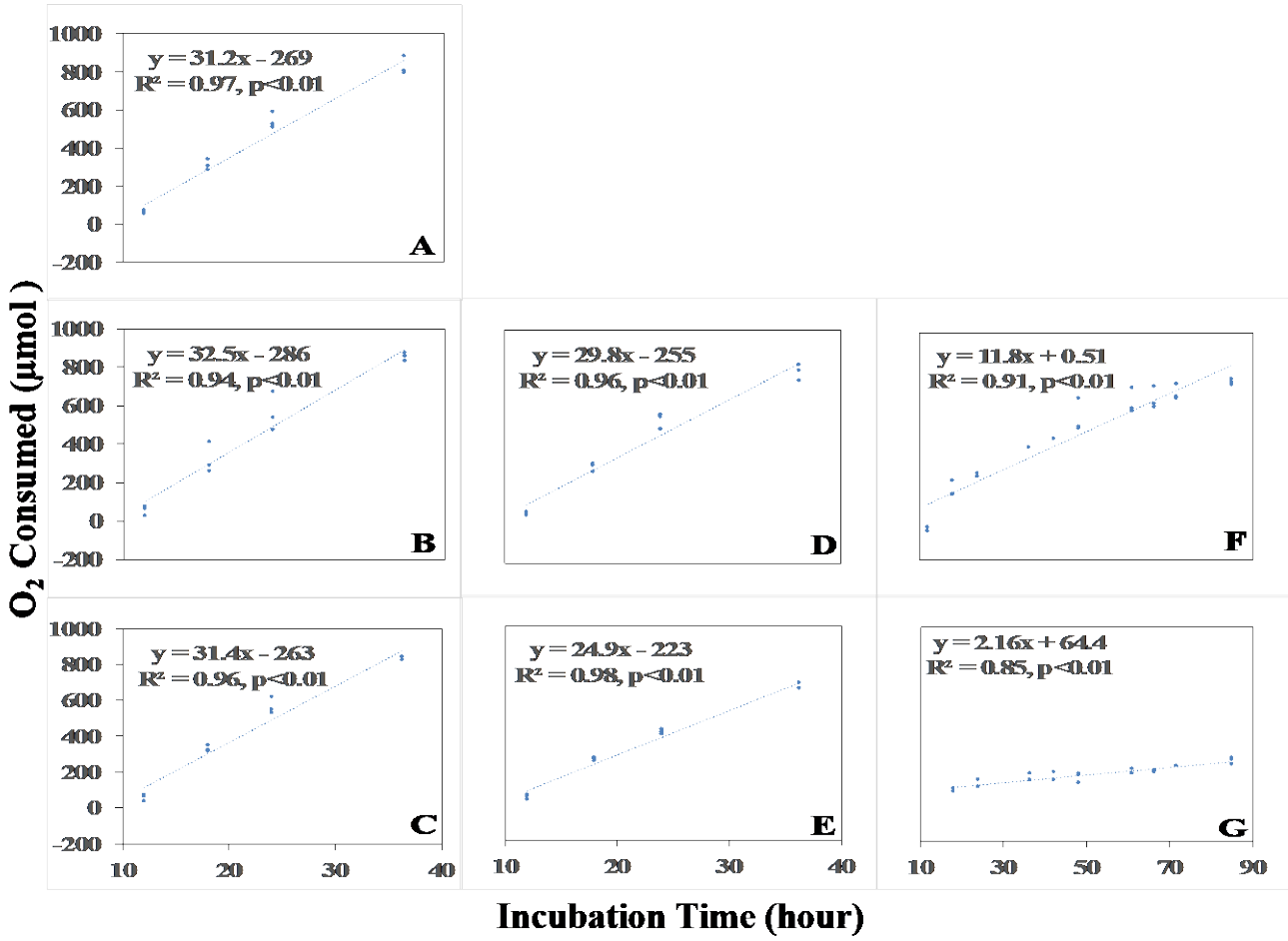

Figure S9. Linear regressions for the respiration rate of *A. borkumensis* SK2 on various alkanes at 35ºC using the three replicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18} and *n*-C_{19} are in the form of liquid; *n*-C_{20} is in the form of wax.

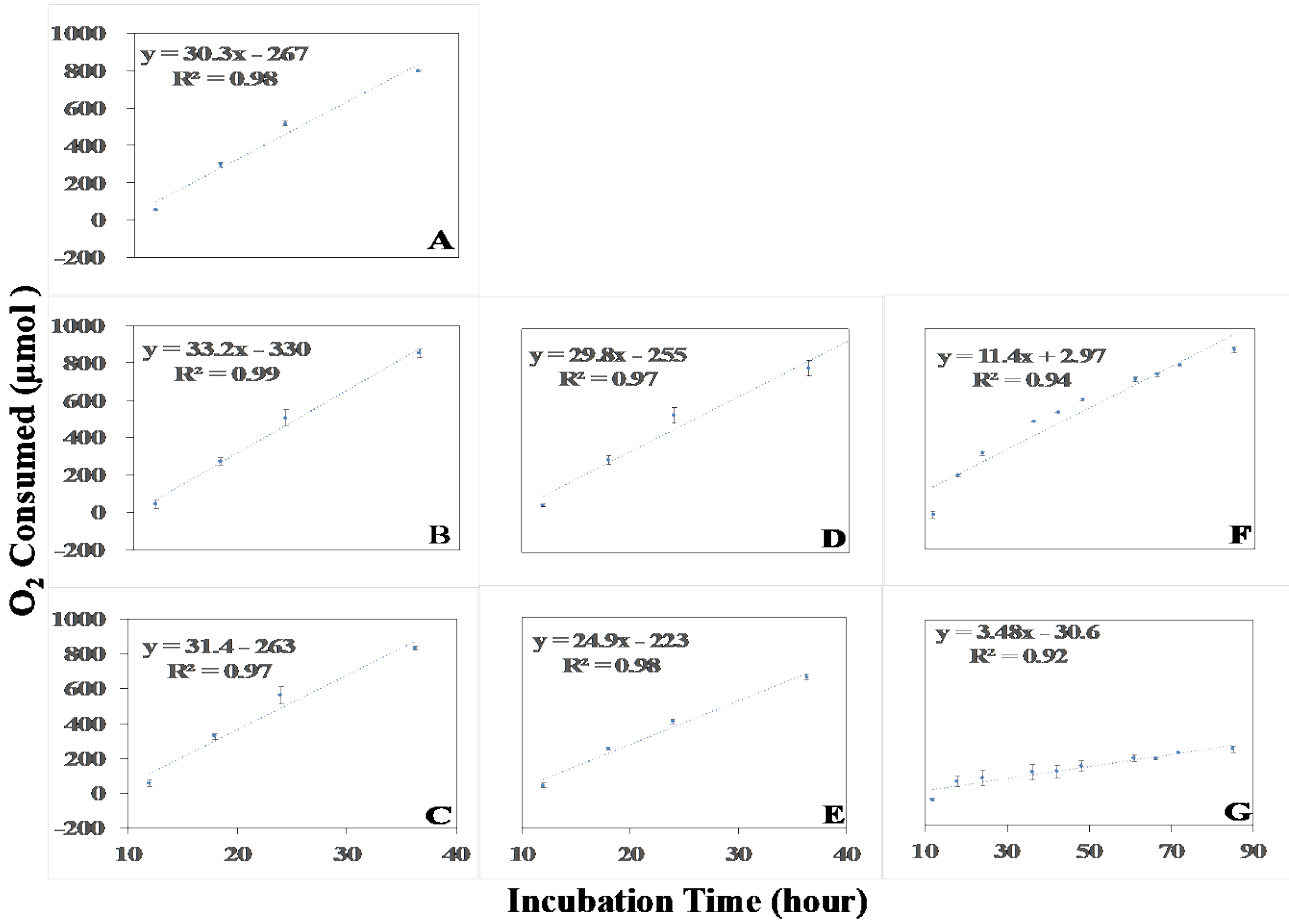

Figure S10. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 35ºC using the mean value of three triplicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18} and *n*-C_{19} are in the form of liquid; *n*-C_{20} is in the form of wax.

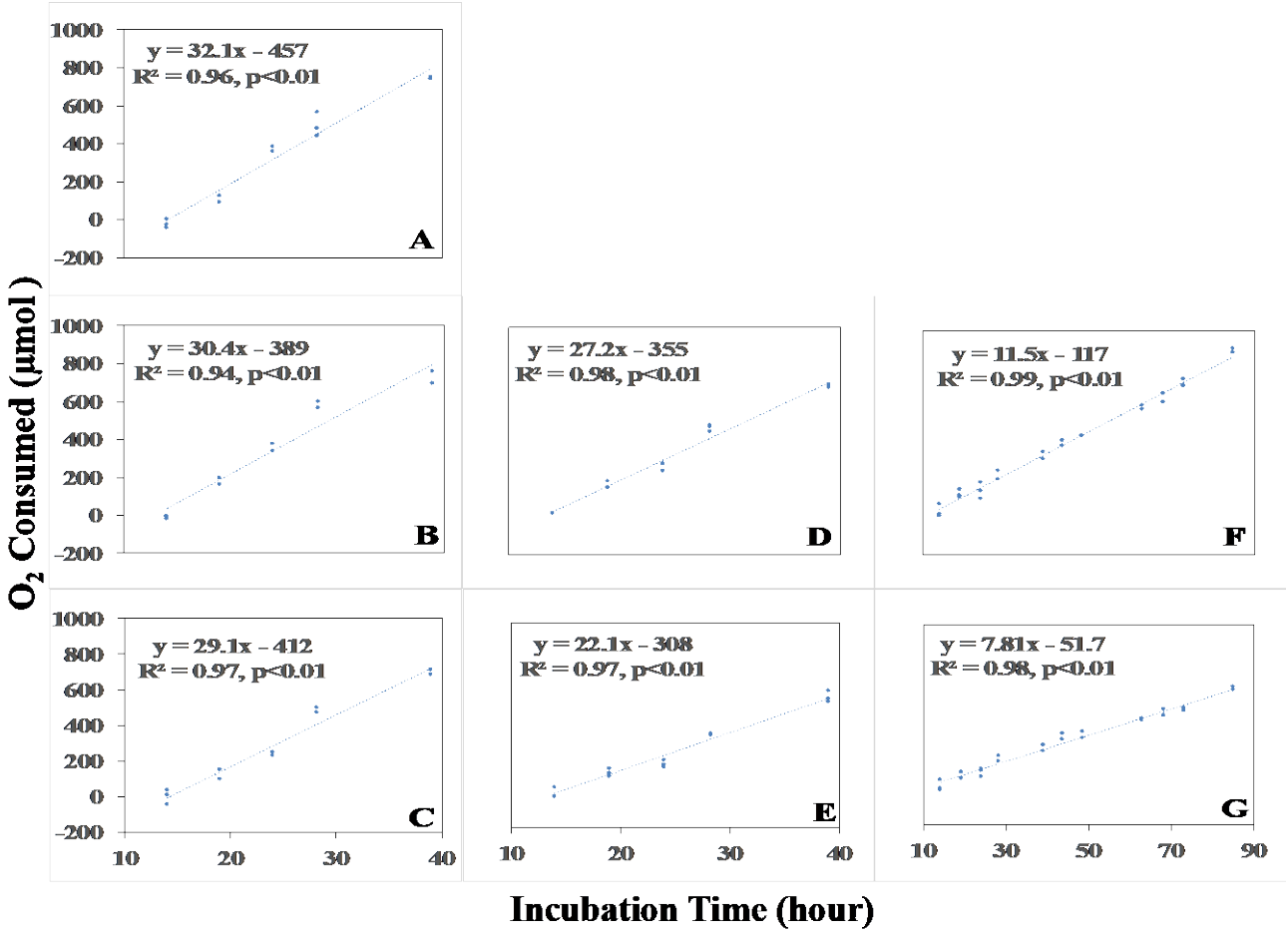

Figure S11. Linear regressions for the respiration rates of *A. borkumensis* SK2 on various alkanes at 40ºC using the three replicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. Seven alkanes are all in the form of liquid.

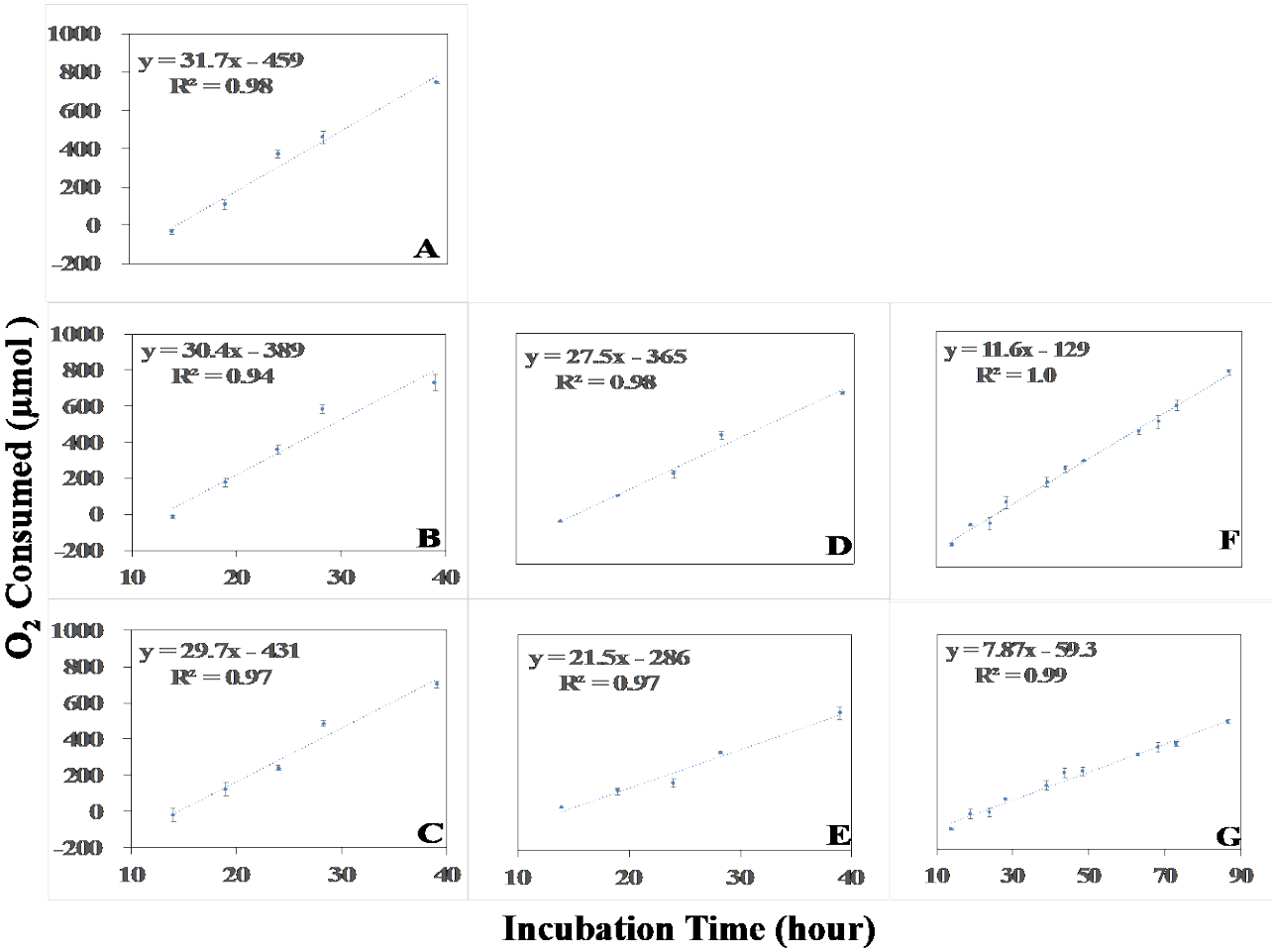

Figure S12. Linear regressions for the respiration rate of *A. borkumensis* SK2 on various alkanes at 40ºC using the mean value of three triplicates at each time point. Panels A, B, C, D, E, F, and G represent *n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, *n*-C_{18}, *n*-C_{19} and *n*-C_{20}, respectively. Seven alkanes are all in the form of liquid.

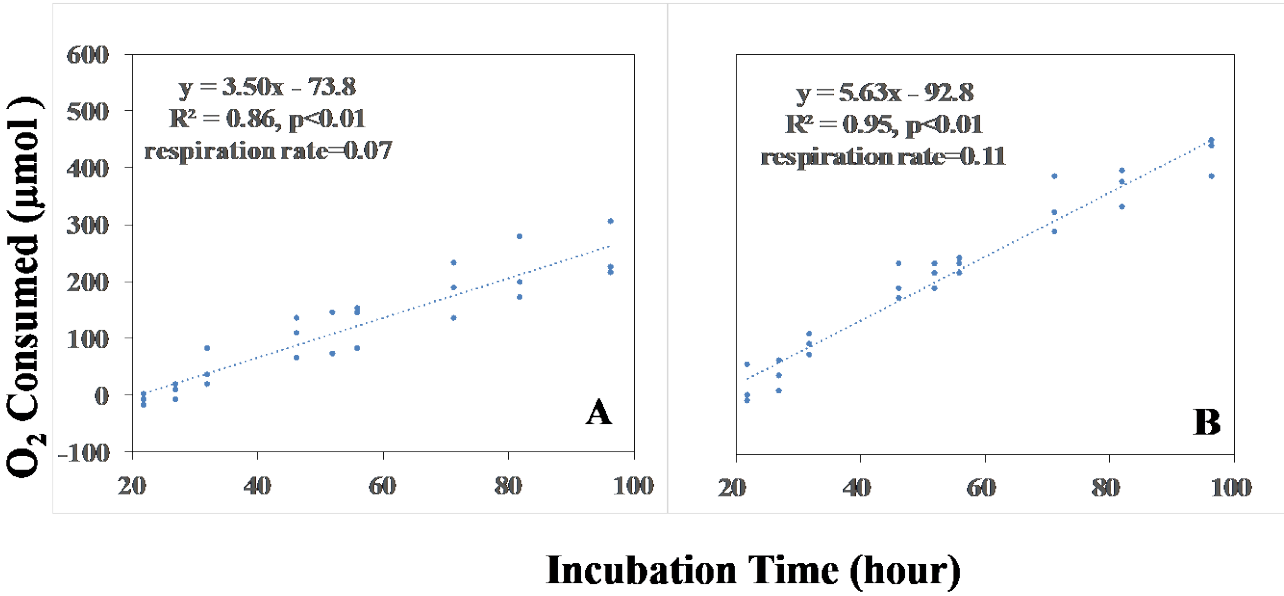

Figure S13. At 25 ºC, linear regressions for the respiration rate of *A. borkumensis* SK2 on wax *n*-C_{19} using the three replicates at each time point. Panels A and B are single particle and microdroplets, respectively. The unit of respiration rate is $\mu mol \cdot h^{-1} \cdot mL^{-1}$ medium.

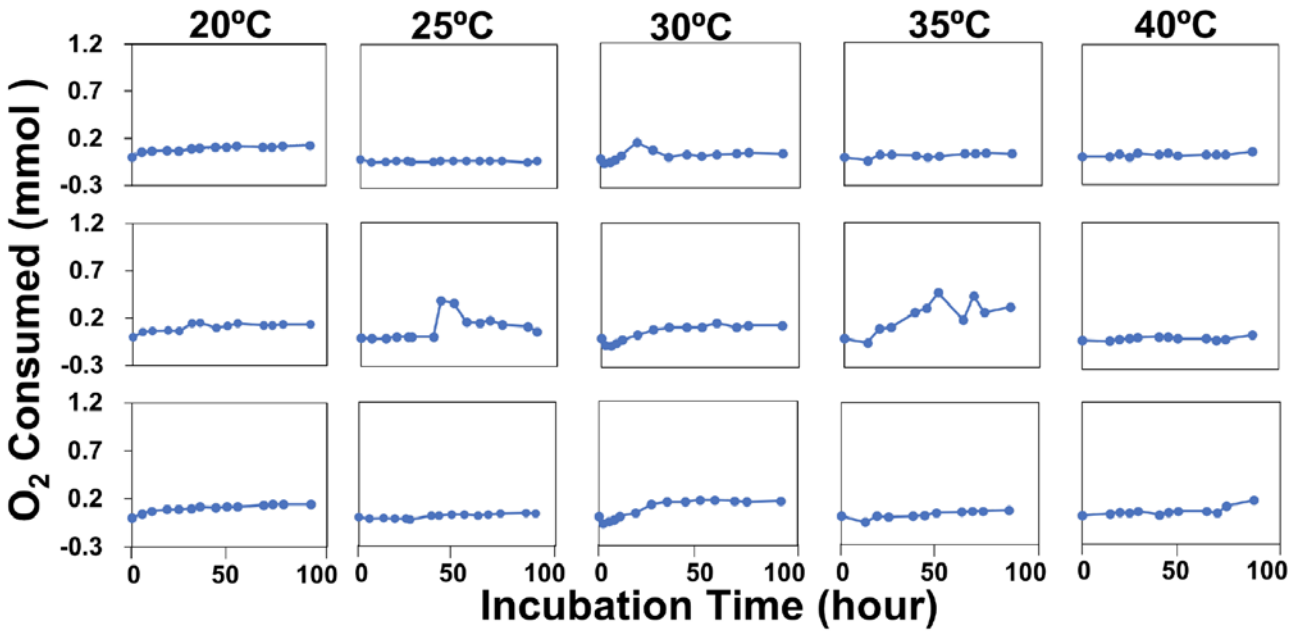

Figure S14. Time series of oxygen consumption for alkane minus control experiments comprising *A. borkumensis* in ONR7a medium, conducted in triplicate at five temperatures. Several control treatments display an initial respiratory pulse, as expected from the inoculum. Sustained respiration after e.g., 30 hours is not observed, in contrast to all experimental treatments.

Tables

Table S1 Doubling time (t_d, h) of *A. borkumensis* SK2 respiration for seven alkanes at five temperatures.

Temperature / Alkanes	20°C	25°C	30°C	35°C	40°C
n-C_{20}	21.3	13.4	15.8	27.7	5.5
n-C_{19}	25.7	22.7	15.3	3.4	5.3
n-C_{18}	21.2	12.2	2.2	3.2	5.0
n-C_{17}	24.7	4.9	2.1	3.0	4.7
n-C_{16}	14.4	5.0	2.7	3.0	5.1
n-C_{15}	8.6	4.6	2.9	3.1	2.5
n-C_{14}	5.3	7.1	2.3	3.1	5.4

Table S2 Oxygen content at each time point during the *A. borkumensis* SK2 growth on seven alkanes at 20ºC (%).

Hour	0	5	10	18	24	31	35	43	49	54	67	72	77	92
n-C_{14}	20.4	20.0	19.5	19.4	19.1	18.2	17.1	14.3	12.7	11.7	10.6	10.2	9.9	9.4
	20.5	20.0	19.6	19.7	19.1	17.7	17.2	14.3	12.6	11.9	10.8	10.3	10.1	9.5
	21.2	20.7	20.3	20.2	19.7	18.8	16.7	14.5	12.8	12.1	11.0	10.7	10.4	9.8
n-C_{15}	20.6	19.8	19.4	19.2	18.8	17.2	16.3	14.3	12.8	11.9	10.7	10.3	10.1	9.5
	19.8	19.3	19.1	18.9	18.5	17.8	16.7	14.4	12.7	11.6	10.5	10.2	10.0	9.4
	20.7	20.2	19.9	19.9	19.5	18.8	17.5	15.3	13.7	12.6	11.1	10.8	10.5	10.1
n-C_{16}	20.7	20.0	19.7	19.6	19.3	16.5	15.3	14.2	13.2	12.3	11.4	11.0	10.9	10.4
	21.6	20.8	20.6	20.5	19.5	18.6	16.7	15.4	14.4	12.5	11.7	11.4	11.2	10.6
	18.7	18.0	17.9	17.8	16.5	15.4	14.3	13.2	11.9	10.7	9.9	9.6	9.4	8.8
n-C_{17}	21.2	20.8	20.6	20.4	20.2	19.7	18.7	17.9	17.4	16.9	15.8	15.2	14.8	13.8
	19.7	19.4	19.2	19.0	18.6	17.8	16.5	14.1	13.3	12.7	12.0	11.5	11.3	10.8
	20.9	20.5	20.2	20.0	20.2	19.8	18.9	18.0	17.3	16.7	15.7	15.0	14.6	13.7
n-C_{18}	20.4	19.7	19.5	19.7	19.6	19.4	19.0	18.8	18.2	17.7	16.7	16.3	15.9	15.3
	20.5	20.0	19.8	19.7	19.5	19.5	18.8	18.6	18.0	17.5	16.5	16.1	15.7	15.1
	21.0	20.3	20.0	19.8	19.2	17.7	13.2	8.3	7.1	1.1	16.5	15.7	15.1	14.3
n-C_{19}	20.6	19.9	19.6	19.7	19.7	19.3	19.0	18.7	18.2	17.8	17.0	16.6	16.4	15.4

	20.9	20.1	19.7	19.9	20.0	19.7	19.4	18.9	18.6	18.2	17.4	17.1	16.8	16.0
	20.5	19.9	19.8	19.7	19.8	19.5	19.2	18.7	17.7	16.0	15.8	13.9	15.1	14.9
n-C_{20}	20.8	20.3	20.0	19.9	20.1	19.6	19.0	18.2	17.9	16.8	15.8	15.4	15.0	14.3
	21.6	20.8	20.8	20.7	20.5	19.9	19.7	18.4	18.1	17.0	16.0	15.6	15.1	14.4
	20.3	19.9	19.6	19.5	19.4	19.2	19.1	19.0	18.6	18.4	17.5	17.4	16.9	16.2
Control	20.9	20.4	20.1	19.9	19.9	19.8	19.6	19.7	19.6	19.6	19.4	19.3	19.3	19.3
	20.8	20.2	20.1	20.0	20.1	19.2	19.1	19.7	19.5	19.2	19.4	19.4	19.3	19.3
	20.6	20.0	19.9	19.8	19.9	19.6	19.5	19.4	19.4	19.3	19.4	19.4	19.3	19.2

Table S3 Oxygen content at each time point during the *A. borkumensis* SK2 growth on seven alkanes at 25ºC (%).

Hour	0	6	13	18	24	26	37	41	47	54	60	66	72	85	90
n-C_{14}	19.5	19.6	19.4	18.9	17.5	16.6	12.8	12.0	11.3	10.8	10.4	10.2	10	9.7	9.6
	17.3	17.7	17.5	17.3	15.7	15.8	11.4	11.0	10.4	10.0	9.5	9.4	9.2	8.8	8.7
	18.5	18.8	18.3	18.1	16.4	15.2	12.8	11.7	11.1	10.5	10.0	9.8	9.6	9.2	9.1
n-C_{15}	18.7	19.4	19.1	18.7	17.8	17.0	12.2	11.7	11.2	10.6	10.1	9.8	9.7	9.3	9.2
	20.2	21.0	20.7	20.2	18.5	17.5	13.1	12.6	12.0	11.3	11.1	10.9	10.7	10.2	10.1
	20.1	20.5	20.3	20.0	18.4	17.5	12.8	12.3	11.8	11.0	10.9	10.7	10.5	10.1	10.0
n-C_{16}	20.3	20.7	20.3	19.7	17.9	16.5	12.3	11.9	11.4	11.0	10.6	10.4	10.2	9.7	9.6
	17.8	18.1	18.1	17.9	16.5	14.7	11.3	10.8	10.3	9.9	9.5	9.3	9.1	8.7	8.7
	20.1	20.4	20.0	18.5	17.0	15.5	12.5	12.3	11.9	11.6	11.2	11.0	10.8	10.3	10.2
n-C_{17}	18.9	19.3	18.9	18.5	17.1	16.2	13.3	12.7	12.2	11.6	11.1	10.8	10.6	10.1	9.9
	19.9	19.9	19.8	19.2	18.4	17.1	13.7	13.2	12.5	11.9	11.5	11.2	11.0	10.4	10.4
	20.1	20.1	19.7	18.8	17.2	16.0	14.0	13.7	13.0	12.4	12.0	11.8	11.5	11.0	11.0
n-C_{18}	20.3	20.5	20.3	20.3	19.8	19.6	18.3	17.9	17.3	16.9	16.4	16.2	15.9	15.2	15.1
	19.8	20.0	20.0	19.8	19.7	19.2	17.9	17.3	16.6	16.5	15.8	15.4	15.0	14.0	13.9
	18.1	18.3	18.1	17.4	15.7	15.1	12.1	11.5	11.4	10.9	10.6	10.4	10.2	9.8	9.7
n-C_{19}	18.5	18.6	18.5	18.5	18.3	18.1	17.9	17.9	16.5	17.4	17.4	17.2	17.2	17.1	17.0

	17.6	18.1	18.0	17.5	17.2	17.0	16.8	16.7	16.6	16.4	16.4	16.4	16.3	15.8	15.7
	20.2	20.6	20.5	20.6	20.5	20.3	19.9	19.6	19.1	19.1	17.5	8.6	16.3	15.8	15.5
n-C_{20}	18.6	18.9	18.5	18.8	18.5	18.4	18.3	18.4	18.1	18.0	16.8	16.7	16.6	16.5	16.0
	18.2	18.5	18.5	18.4	18.1	18.0	17.5	17.0	16.9	16.6	16.1	15.8	15.6	15.6	15.4
	20.5	20.8	20.8	20.7	20.9	20.9	20.7	20.6	20.5	20.5	20.2	20.1	20.1	19.9	19.8
Control	19.5	19.7	19.6	19.7	19.7	19.8	19.3	19.3	19.2	19.2	19.3	19.2	19.1	19.0	19.1
	17.7	17.8	17.8	17.6	17.6	17.6	17.6	13.4	13.7	15.9	16.0	15.7	16.2	16.4	17.0
	19.8	20.2	20.1	20.0	20.0	20.1	20.1	20.0	20.0	20.0	20.0	20.0	20.0	20.2	20.0

Table S4 Oxygen content at each time point during the *A. borkumensis* SK2 growth on seven alkanes at 30ºC (%).

Hour	0	2	5	8	11	18	26	34	43	51	58	68	74	91
n-C_{14}	18.8	19.8	19.7	19.4	18.9	17.9	14.1	11.8	11.2	10.9	10.5	10.0	9.7	9.3
	18.3	19.0	19.1	18.7	18.2	17.4	13.3	11.2	10.4	10.1	9.7	9.1	8.8	8.4
	18.6	19.5	19.3	19.1	18.9	18.6	15.2	11.9	10.8	10.2	9.7	9.3	8.9	8.4
n-C_{15}	20.1	20.9	20.8	20.7	20.2	19.6	16.9	13.2	12.1	11.5	11.1	10.6	10.3	9.7
	18.3	19.2	19.2	18.9	18.5	17.8	15.3	12.3	11.5	10.9	10.2	10.2	10.0	9.5
	18.0	18.7	18.7	18.6	18.2	17.9	14.9	11.9	10.9	10.3	10.0	9.5	9.2	8.8
n-C_{16}	19.9	20.6	20.3	20.3	19.9	19.7	16.9	13.5	11.7	11.1	10.7	10.3	10.0	9.5
	18.0	18.8	18.8	18.6	18.3	17.5	14.1	12.3	11.3	10.9	10.5	9.8	9.8	9.6
	20.8	21.5	21.2	21.0	20.7	20.5	17.9	14.7	12.6	11.9	11.5	10.8	10.7	10.2
n-C_{17}	20.2	21.0	21.0	20.8	20.4	19.2	15.4	13.2	12.2	11.8	11.3	10.8	10.6	10.2
	17.3	18.2	18.2	18.0	17.4	16.4	14.3	12.2	11.3	10.6	10.2	9.6	9.4	9.2
	19.9	20.8	20.6	20.5	20.0	19.3	15.8	13.8	12.5	12.0	11.6	11.2	10.9	10.7
n-C_{18}	20.4	21.0	21.0	20.7	20.5	20.0	17.8	15.8	14.1	13.4	12.9	12.3	11.9	11.2
	20.2	20.7	20.4	20.3	20.0	19.5	17.6	15.2	13.8	12.8	12.4	11.8	11.5	10.5
n-C_{19}	20.3	21.0	21.0	20.5	20.3	20.5	20.4	20.3	20.0	19.6	19.3	19.0	18.8	18.2
	19.7	20.5	20.4	20.2	19.8	20.2	20.0	20.0	19.4	19.1	18.7	18.5	18.2	17.9

	20.7	21.5	21.4	21.4	21.0	21.0	20.1	20.7	20.2	20.0	19.6	18.8	18.6	17.8
n-C_{20}	20.9	21.6	21.6	21.3	21.2	21.2	20.8	20.7	20.3	20.0	19.6	19.0	18.7	18.1
	21.0	21.9	21.6	21.4	21.3	21.4	21.0	20.9	20.5	20.2	19.8	19.2	18.9	18.3
	18.4	19.2	19.1	18.7	18.1	17.2	15.5	16.1	15.4	14.2	15.0	14.5	14.6	14.0
Control	18.7	19.5	19.3	19.1	18.7	18.3	17.3	17.0	17.0	16.8	16.8	16.9	17.0	16.9
	18.8	19.6	19.7	19.4	19.0	18.4	17.8	17.5	17.5	17.5	17.0	17.5	17.3	17.3
	18.7	19.2	19.1	18.8	18.3	16.8	17.7	18.5	18.2	18.4	18.2	18.1	18.0	18.1

Table S5 Oxygen content at each time point during the *A. borkumensis* SK2 growth on seven alkanes at 35ºC (%).

Hour	0	12	18	24	36	42	48	61	66	72	85
n-C_{14}	20.5	19.9	17.3	14.8	11.5	11.1	10.8	9.7	9.7	9.6	9.1
	21.1	20.3	17.3	14.5	11.2	10.8	10.5	9.4	9.5	9.3	9.1
	21.0	20.4	17.6	15.1	12.1	11.8	11.5	10.4	10.4	10.4	10.0
n-C_{15}	21.4	20.6	16.8	13.9	11.8	11.7	11.4	10.6	10.7	10.6	10.4
	21.1	20.8	18.2	15.8	11.8	11.5	11.2	10.3	10.2	10.2	9.8
	21.2	20.5	18.0	15.2	11.4	11.2	10.7	9.7	9.8	9.7	9.4
n-C_{16}	20.3	19.9	16.8	14.4	11.3	11.2	10.9	10.1	10.2	10.1	9.7
	21.1	20.3	17.2	14.2	11.7	11.5	11.3	10.4	10.4	10.4	10.0
	21.1	20.4	17.5	15.1	11.6	11.5	11.2	10.3	10.3	10.2	9.8
n-C_{17}	20.8	20.3	17.8	15.3	12.5	12.3	12.0	10.9	10.9	10.8	10.5
	21.3	20.7	17.8	15.1	12.4	12.1	11.9	10.9	11.0	11.0	10.6
	21.2	20.5	17.8	14.9	12.0	11.9	11.6	10.7	10.8	10.7	10.4
n-C_{18}	21.0	20.7	18.1	16.6	13.7	12.9	12.4	11.3	11.3	11.2	10.8
	21.4	20.9	18.7	16.9	14.1	13.4	12.5	11.3	11.3	11.1	10.7
	20.8	20.2	18.0	16.1	13.2	12.7	12.0	11.0	11.0	10.7	10.4
n-C_{19}	20.9	20.9	17.7	15.7	13.3	12.8	12.0	11.3	11.2	11.0	10.7

	21.4	21.7	19.2	17.9	15.9	15.3	14.5	13.4	13.1	12.5	11.4
	20.7	20.7	18.4	17.0	15.2	14.6	13.9	12.5	12.2	11.7	10.9
n-C_{20}	20.7	21.3	20.3	20.2	19.8	19.7	19.3	18.7	18.6	18.2	18.1
	20.4	20.9	19.5	19.2	18.8	18.8	18.5	18.1	18.2	17.9	17.5
	20.4	20.4	19.3	18.8	18.4	18.3	17.3	16.8	17.2	17.4	15.6
Control	21.1	21.8	21.1	21.2	21.1	21.0	20.7	20.6	20.5	20.5	20.4
	19.6	20.1	18.5	18.3	16.6	16.1	14.3	17.5	14.7	16.6	16.0
	20.4	20.8	20.1	20.1	20.2	20.4	20.3	20.0	20.0	19.9	20.0

Table S6 Oxygen content at each time point during the *A. borkumensis* SK2 growth on seven alkanes at 40ºC (%).

Hour	0	14	19	24	28	39	44	49	63	68	73	87
n-C_{14}	21.0	21.5	19.6	14.2	14.7	12.6	12.4	12.2	11.0	10.9	10.5	10.1
	20.8	20.8	18.3	16.5	15.4	12.5	12.1	11.9	11.2	10.7	10.5	10.0
	20.6	20.9	19.6	16.6	15.7	13.7	12.7	12.1	11.0	10.5	10.4	9.9
n-C_{15}	17.7	18.7	17.6	17.3	14.9	13.1	12.2	11.3	9.9	9.6	9.4	9.0
	19.8	20.0	18.0	16.0	13.5	12.0	11.6	11.3	10.6	10.4	10.2	10.0
	20.1	20.2	17.9	15.9	13.4	11.6	11.2	11.2	10.7	10.6	10.5	10.4
n-C_{16}	21.0	20.6	20.8	19.9	18.2	14.5	13.2	12.2	11.1	10.9	10.8	10.4
	20.1	20.6	19.0	17.5	14.8	12.1	11.6	11.3	10.8	10.6	10.5	10.3
	18.3	18.2	16.6	15.5	12.7	10.6	10.1	10.0	9.0	9.0	8.9	8.9
n-C_{17}	20.4	20.2	18.7	17.3	15.0	12.6	12.1	11.8	11.2	11.2	11.1	10.7
	20.7	19.5	18.6	17.6	15.4	13.0	12.5	12.2	11.4	11.3	11.2	10.8
	19.0	18.8	17.3	16.3	14.0	11.4	10.9	10.8	10.3	10.2	10.1	9.7
n-C_{18}	18.7	18.9	17.4	16.8	15.9	12.7	11.9	11.4	10.3	10.3	10.0	9.7
	20.0	19.6	18.9	18.3	16.1	13.3	12.6	12.4	11.5	11.4	11.1	10.8
	18.5	18.1	16.9	16.3	14.7	12.3	11.6	11.3	10.4	10.4	10.1	9.7
n-C_{19}	21.4	21.3	20.2	20.3	19.1	17.9	17.1	16.5	14.9	14.5	13.5	11.3

	20.8	20.6	19.5	19.2	18.0	16.9	16.2	15.9	14.1	13.4	12.5	10.9
	21.0	20.2	19.3	18.9	17.3	13.4	12.4	12.3	11.4	11.5	11.2	10.8
n-C_{20}	21.2	20.4	19.9	19.7	18.8	15.8	14.0	13.3	12.3	12.2	12.0	11.6
	21.3	21.1	20.4	20.3	19.3	18.6	17.8	17.7	16.5	16.2	15.7	14.5
	21.5	21.4	20.2	20.1	19.5	18.4	17.6	17.5	16.6	16.0	16.1	14.5
Control	21.2	21.0	20.8	20.9	20.7	21.1	20.8	20.7	20.7	20.9	20.1	19.4
	20.8	20.9	20.7	20.6	20.5	20.4	20.4	20.6	20.6	20.8	20.7	20.2
	20.7	20.7	20.4	20.8	20.3	20.5	20.3	20.6	20.5	20.5	20.5	20.1