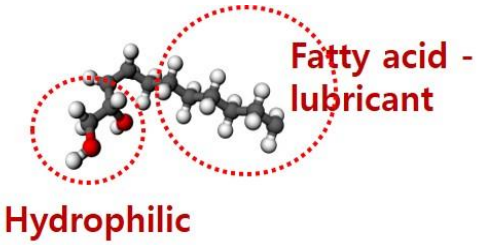

Fig. S1. A schematic diagram of multi-alcohol processing aids.

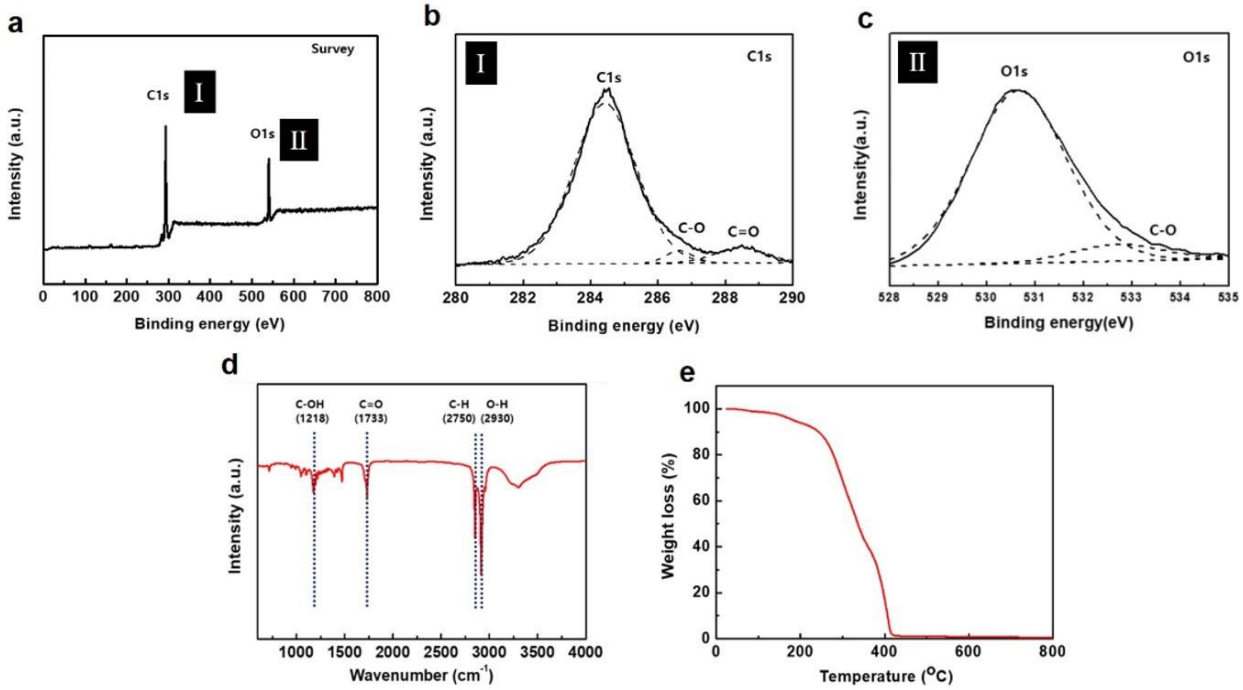

Fig S2. Characterization of as-prepared E-A-S.

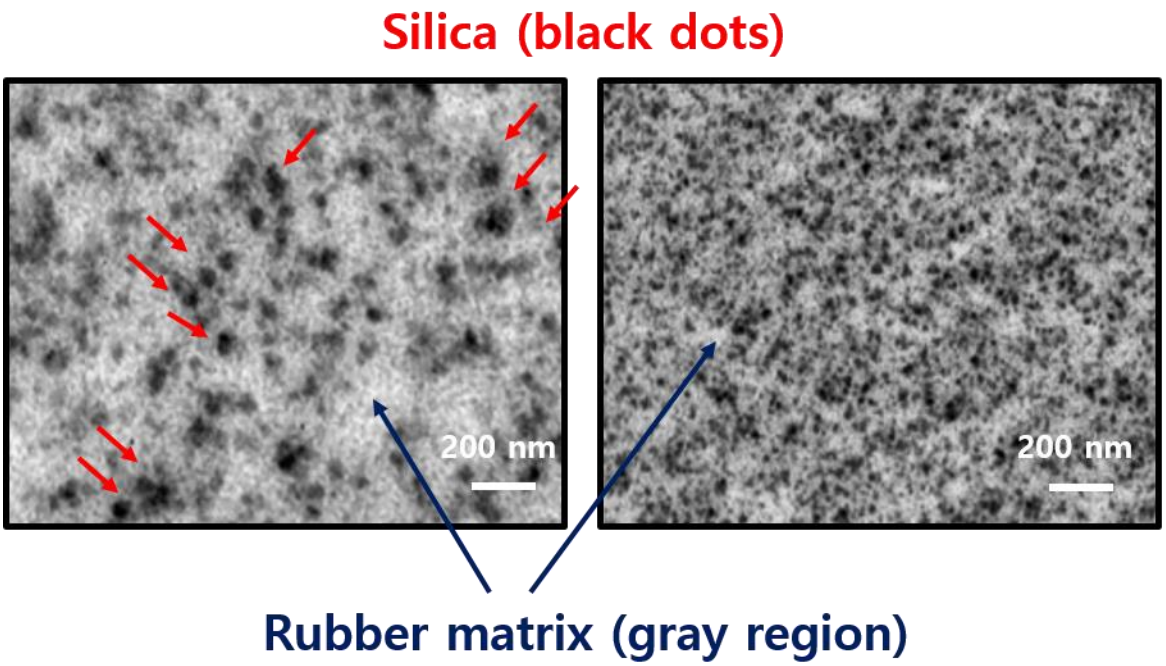

Fig S3. a) TEM images of rubber composites without processing aids. b) TEM images of rubber composites with M-A-S.

Table S1. Formulation of the rubber composites

Unit: phr

Materials	Control	Ca-S	Zn-S	E-S	M-A-S	Injection Material	Injection Time
SBR	60	60	60	60	60		
Silica	40	40	40	40	40		
Stearic Acid	1	1	1	1	1	SBR	0
Ca-S	-	2	-	-	-	Silica	30
Zn-S	-	-	2	-	-	Master Batch	100
E-S	-	-	-	2	-		
E-A-S	-	-	-	-	2	Chemical	180
ZnO	2	2	2	2	2	Drop	300
Sulfur	1.75	1.75	1.75	1.75	1.75		
TBBS	1	1	1	1	1		

Table S2. Swelling and crossing density characteristics or rubber vulcanizates

Materials	Control	Ca-S	Zn-S	E-S	M-A-S
Equilibrium swelling (%)	127.1 ± 0.7	141.2±0.3	139.7±0.2	137.5±0.5	167.13±0.5
Crosslinking density (mol/g·10^{-4})	2.37±0.5	2.65±0.7	2.61±0.3	2.59±0.2	2.97±0.5

Table S3. Fatigue properties of rubber composites with different processing aids

Materials	Control	Ca-S	Zn-S	E-S	M-A-S
3,000 cycles	1.52	1.54	1.53	1.45	1.44
6,000 cycles	2.18	2.45	2.48	2.11	2.06
10,000 cycles	3.15	3.18	3.31	3.13	3.08
dc/dn	1.15	1.16	1.25	1.14	1.02