

## Supporting information

### Non-Stoichiometric Copper Sulfide Nanostructures at the Brass-Rubber Interface: Implications for Rubber Vulcanization Temperature in the Tire Industry

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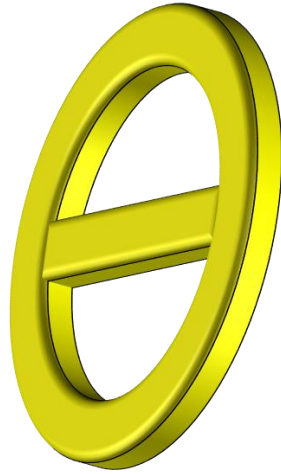
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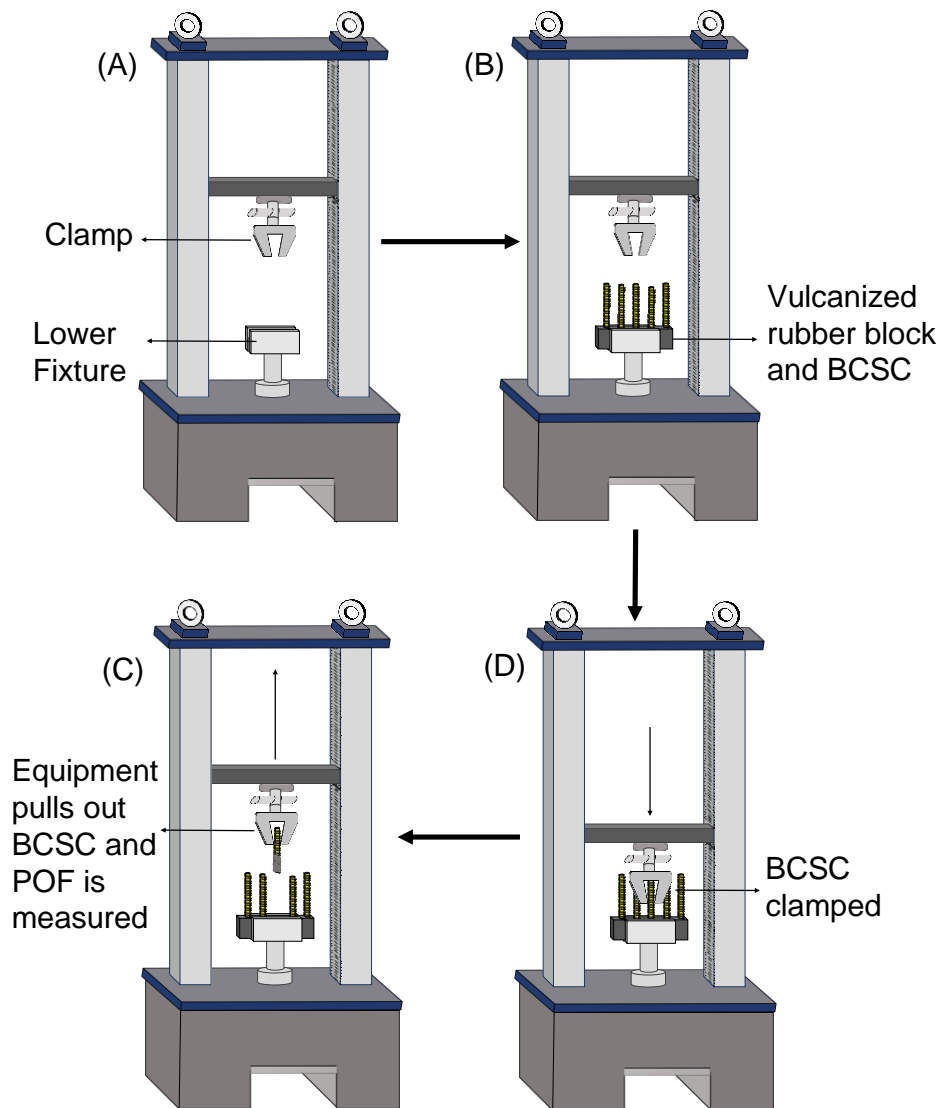
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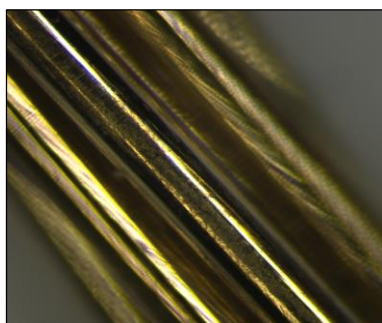
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**Figure S1.** Schematic image of laser cut mesh from brass foil that is used for interfacial thickness experiment.



**Figure S2.** Schematic showing pull-out force measurement procedure.



Unreacted brass



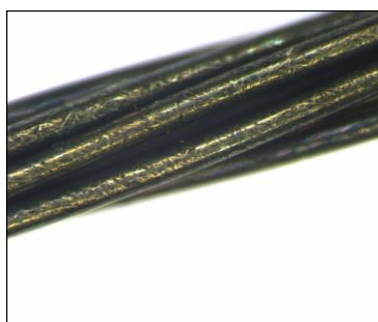
Vulcanized at 130 °C



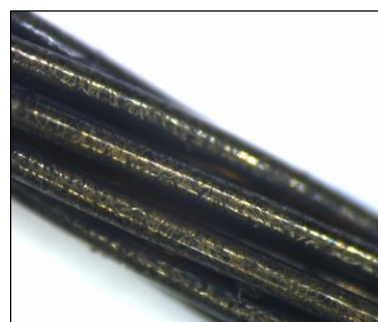
Vulcanized at 140 °C



Vulcanized at 150 °C

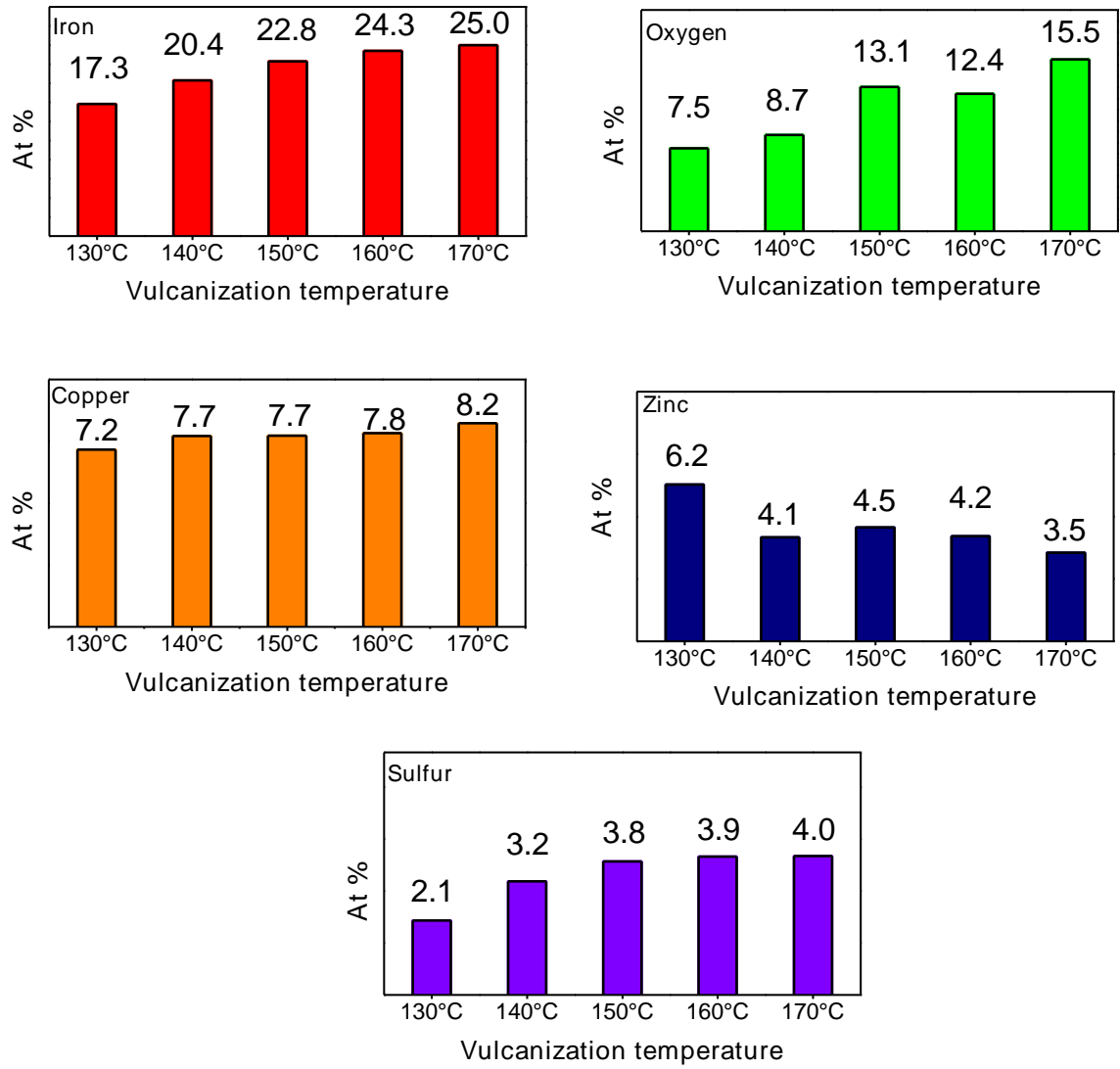


Vulcanized at 160 °C

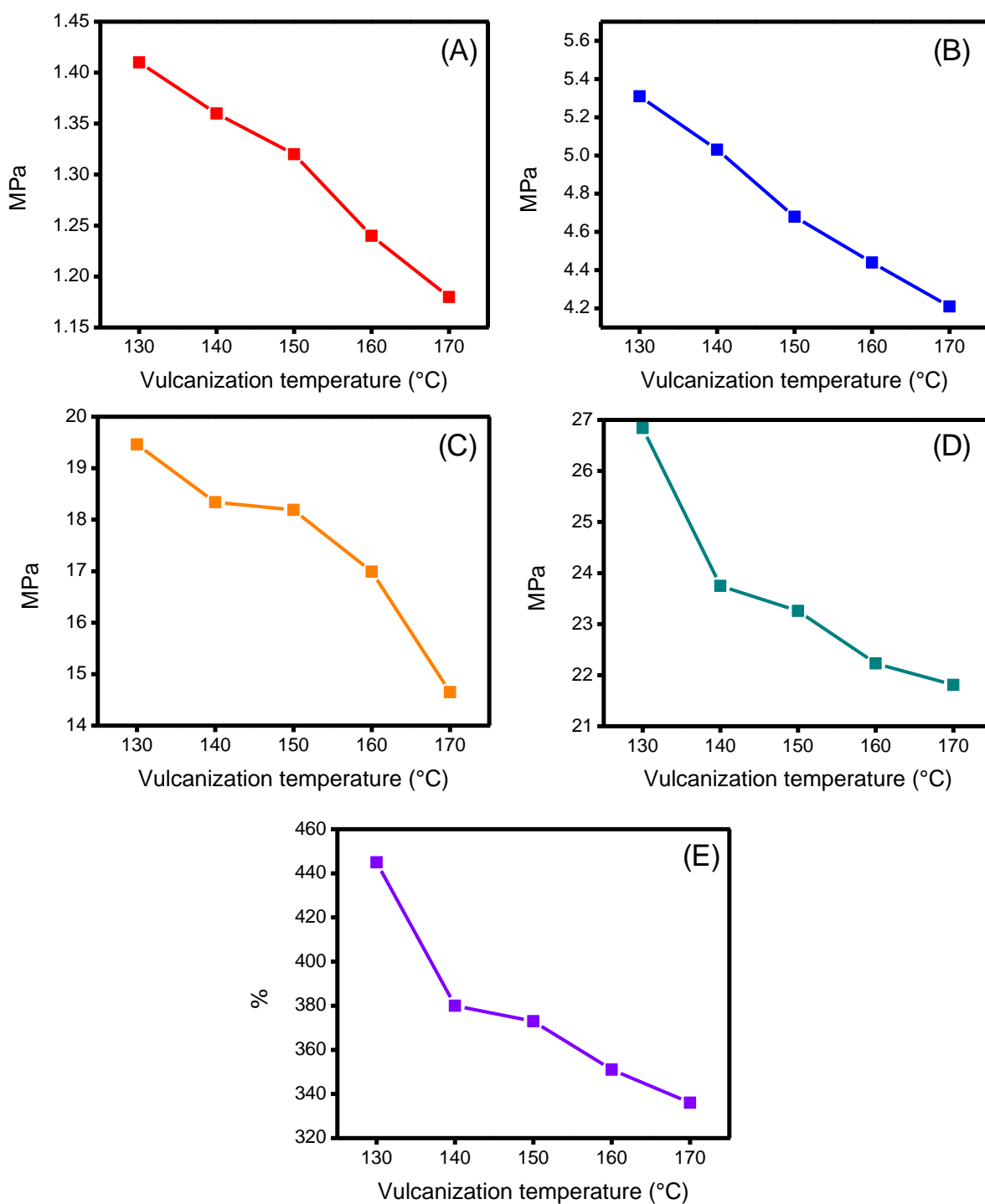


Vulcanized at 170 °C

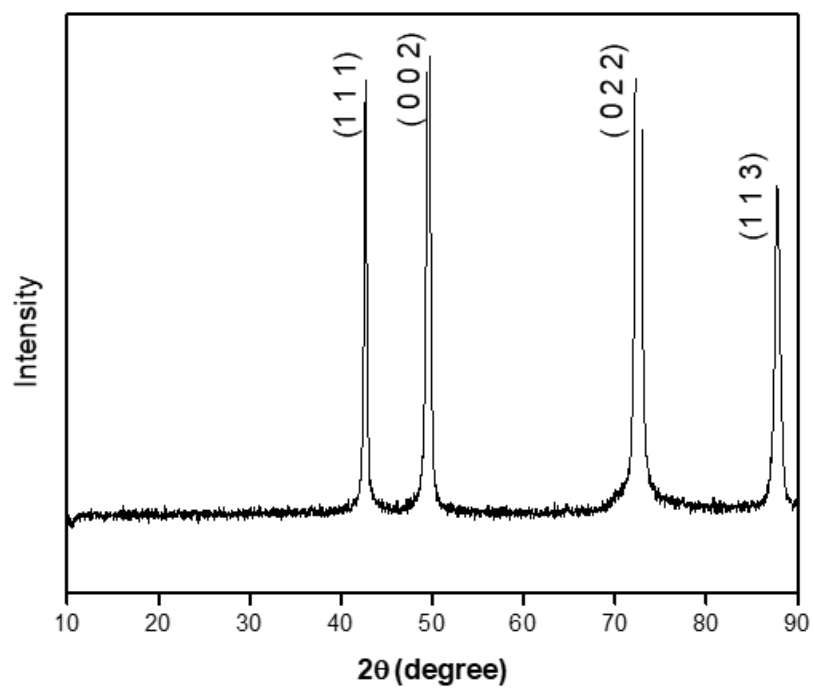
**Figure S3.** Microscopic images of reacted brass-coated steel cords with change in vulcanization temperature. Scale: 50x.



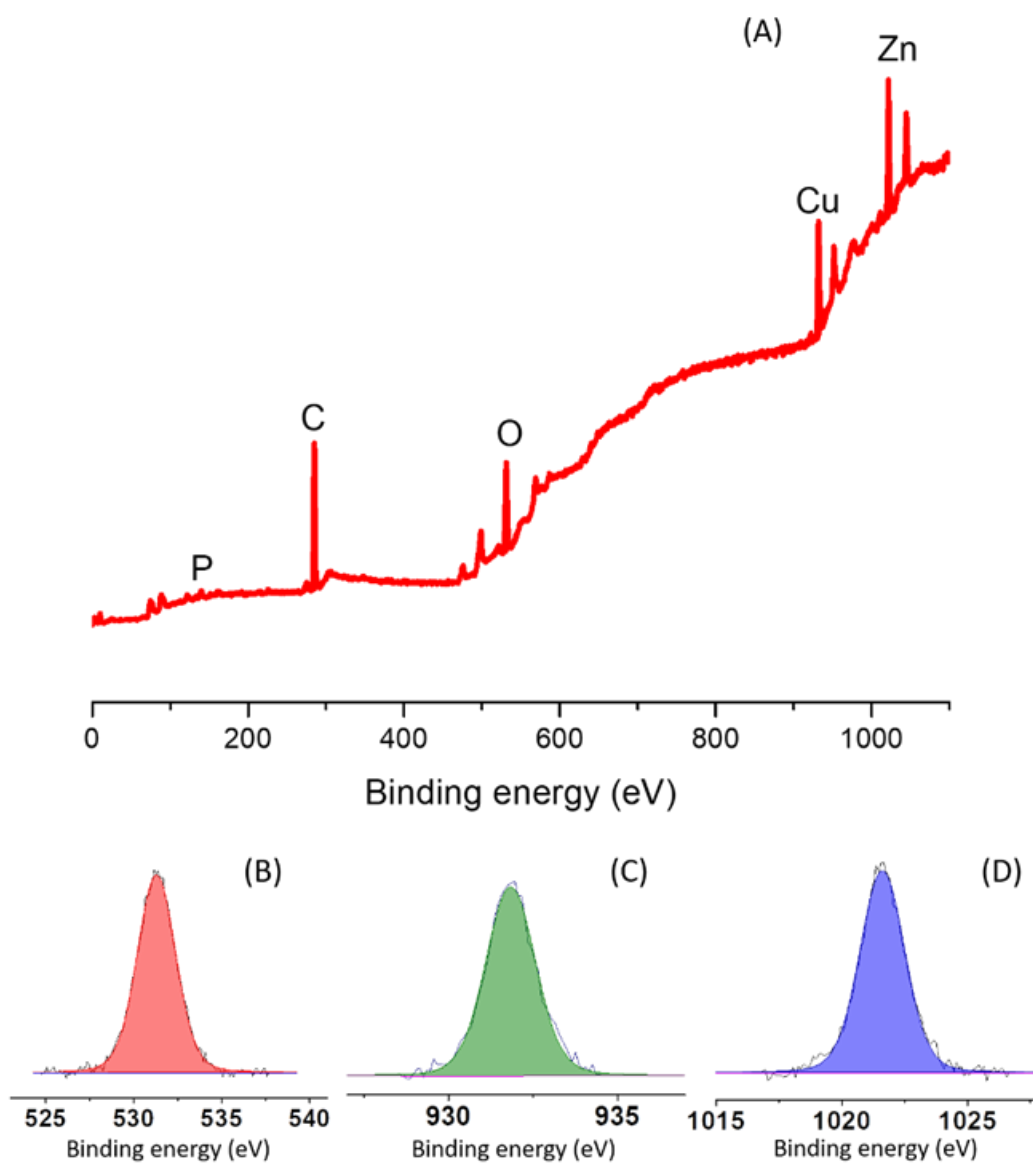
**Figure S4.** SEM-EDS data of vulcanized cords.



**Figure S5.** Physical properties of rubber compound with increasing vulcanization temperature : (A) 10 % modulus, (B) 100 % modulus, (C) 300 % modulus, (D) Tensile strength and (E) EB.

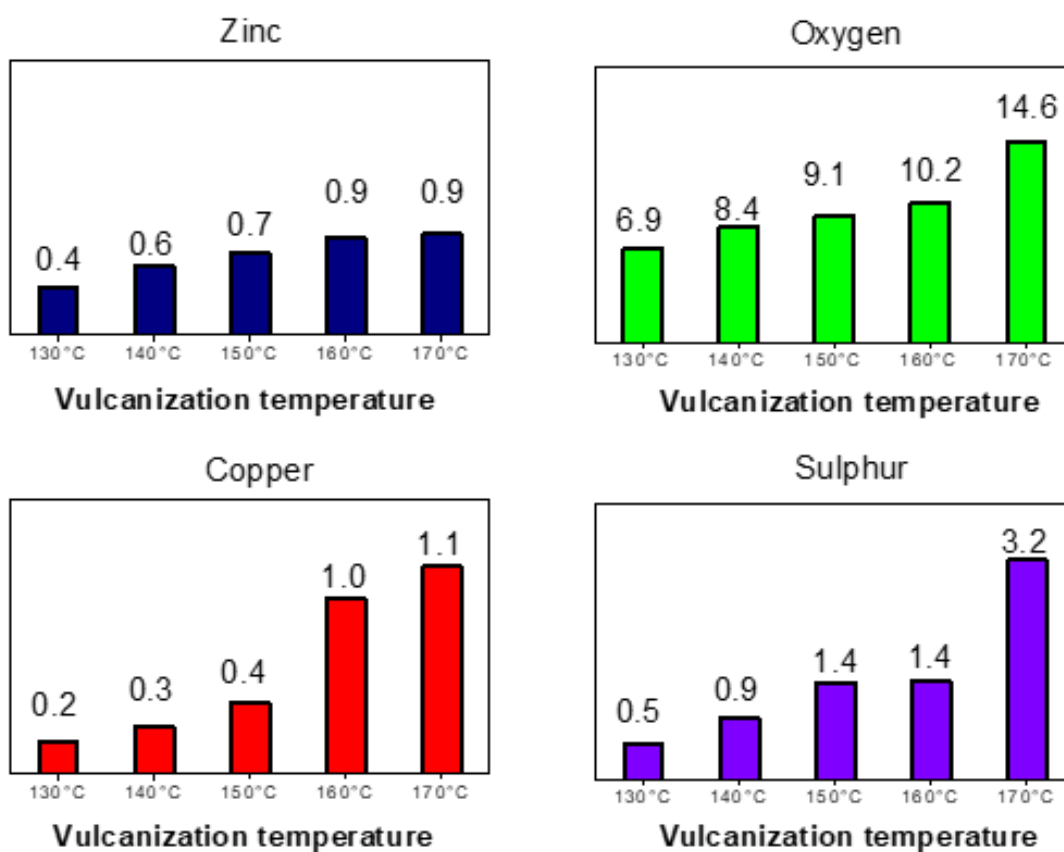


**Figure S6.** XRD pattern of un-vulcanized brass-coated steel cord.

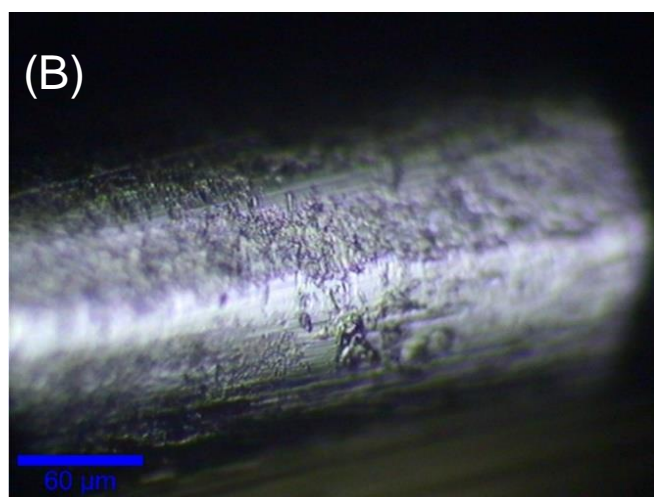
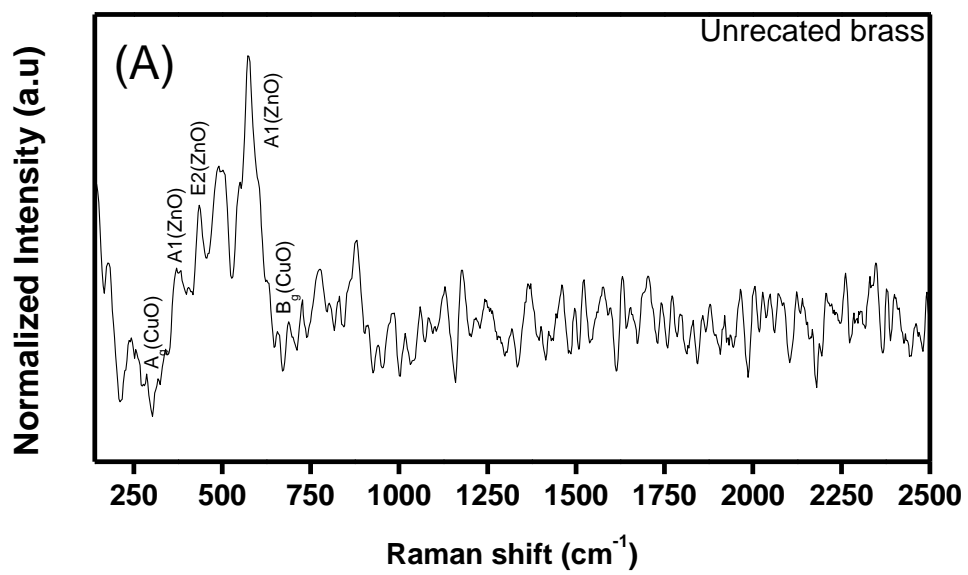


**Figure S7.** (A) XPS survey spectra of unreacted brass-coated steel cord under ambient conditions. (B), (C) and (D) High resolution XPS spectra of O 1s, Cu 2p<sub>3/2</sub> and Zn 2p<sub>3/2</sub>.





**Figure S8.** Relative atomic % obtained from XPS.



**Figure S9.** (A) Raman spectra of unreacted brass-coated steel cord and (B) LED white light image of unreacted brass-coated steel cord.

**Table S1.** Total crosslink density of rubber compound at different vulcanization temperature.

<b>Vulcanization temperature (°C)</b>	<b>Total crosslink density (mol/cc)</b>
130	9.42 E-05
140	1.30 E-04
150	1.56 E-04
160	1.93 E-04
170	2.42 E-04