Mechanical and Rheological Behaviour of Hybrid Crosslinked Rubber

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Abstract: Physical interactions contribute to the strength and toughness enhancement of rubber materials. Herein, we report a kind of hybrid crosslinked rubber comprised of covalent , hydrogen bond and ionic bond crosslinking. 2 -acrylamido-2--methyl propane sulfonic acid(AMPS) and Zinc oxide(ZnO) were incorporated into nitrile butadiene rubber(NBR) via internal milling together with dicumyl peroxide(DCP). For there are double bond and sulfonic acid group in AMPS molecule, AMPS could be grafted onto NBR molecule chains and react with ZnO during the following vulcanization procedure. Consequently, a hybrid crosslinked network comprised of covalent bond, hydrogen bond between amide groups and ionic bond between Sulfonate ion and Zinc ion could be built up in NBR in this simple method, which could significantly influence the mechanical and rheological behaviour of vulcanized NBR.

Preparation of hybrid crosslinked NBR

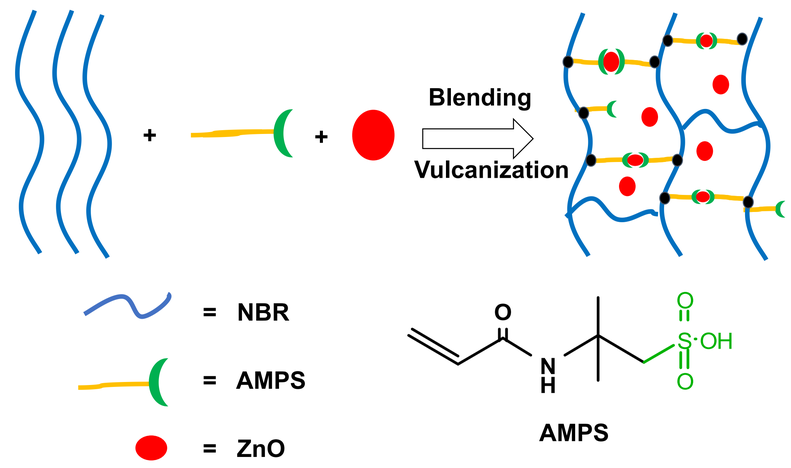

Fig. 1. Schematic for a sample reaction of NBR, AMPS, ZnO and DCP to prepare hybrid crosslinked rubber.

Characterization of hybrid crosslinked NBR

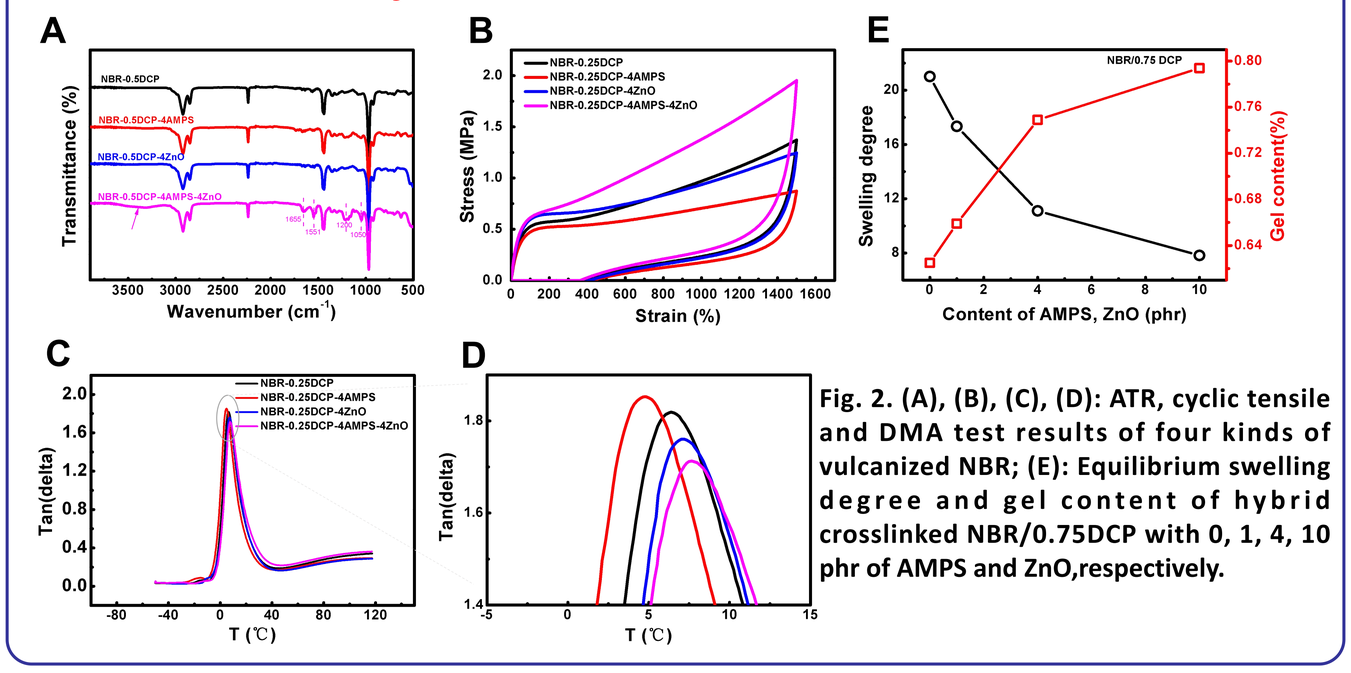

Fig. 2. (A), (B), (C), (D): ATR, cyclic tensile and DMA test results of four kinds of vulcanized NBR; (E): Equilibrium swelling degree and gel content of hybrid crosslinked NBR/0.75DCP with 0, 1, 4, 10 phr of AMPS and ZnO,respectively.

Reaction model of AMPS and ZnO

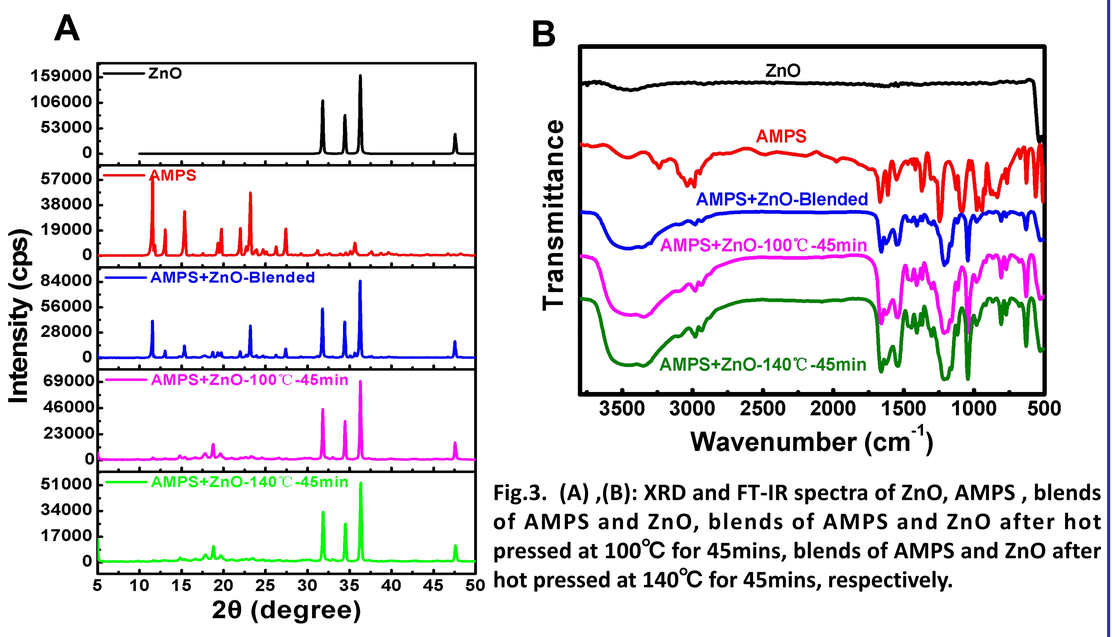

Fig.3. (A) ,(B): XRD and FT-IR spectra of ZnO, AMPS , blends of AMPS and ZnO, blends of AMPS and ZnO after hot pressed at 100℃ for 45mins, blends of AMPS and ZnO after hot pressed at 140℃ for 45mins, respectively.

Rheological behaviour

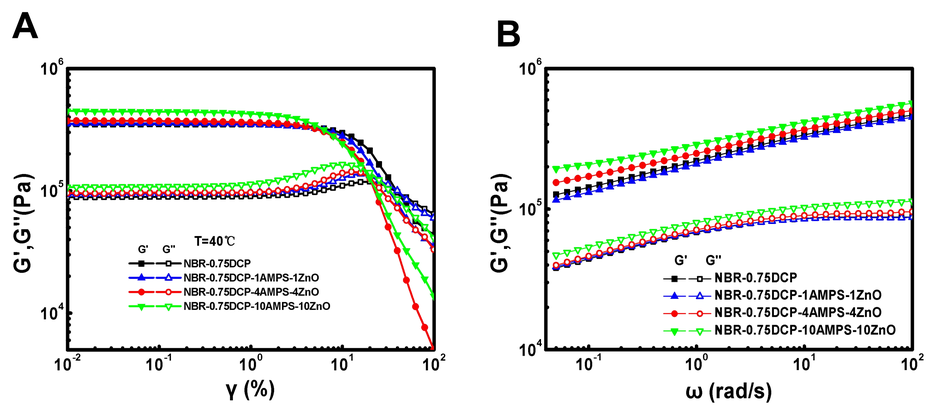

Fig.6. (A), (B): Strain sweep and frequency sweep curves of hybrid crosslinked NBR/0.75DCP with 0, 1, 4, 10 phr of AMPS and ZnO at a fixed temperature of 40℃.

Mechanical behaviour

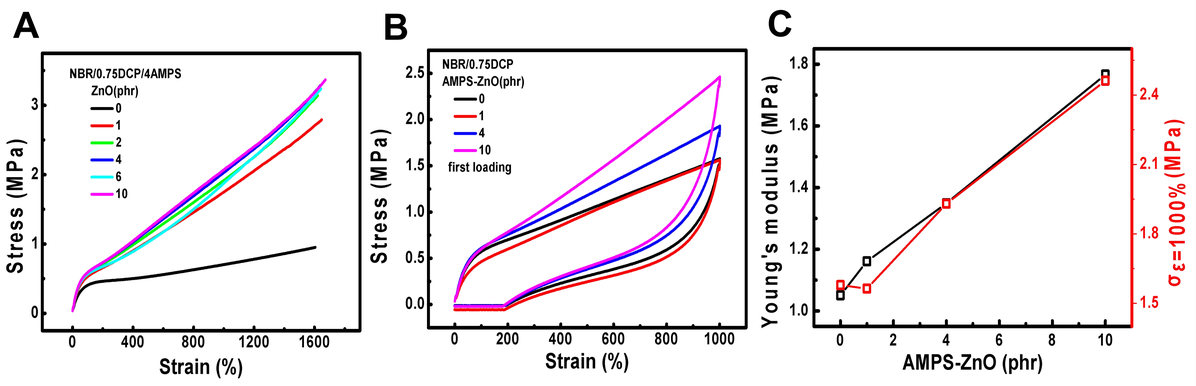

Fig. 4. (A) Single axial tensile curves of hybrid crosslinked NBR/0.75DCP/4AMPS with 0, 1, 2, 4, 6, 10 phr of ZnO; (B), (C): Cyclic tensile curve , Young's modulus and stress at a fixed strain of 1000% of hybrid crosslinked NBR/0.75DCP with 0, 1, 4, 10 phr of AMPS and ZnO.

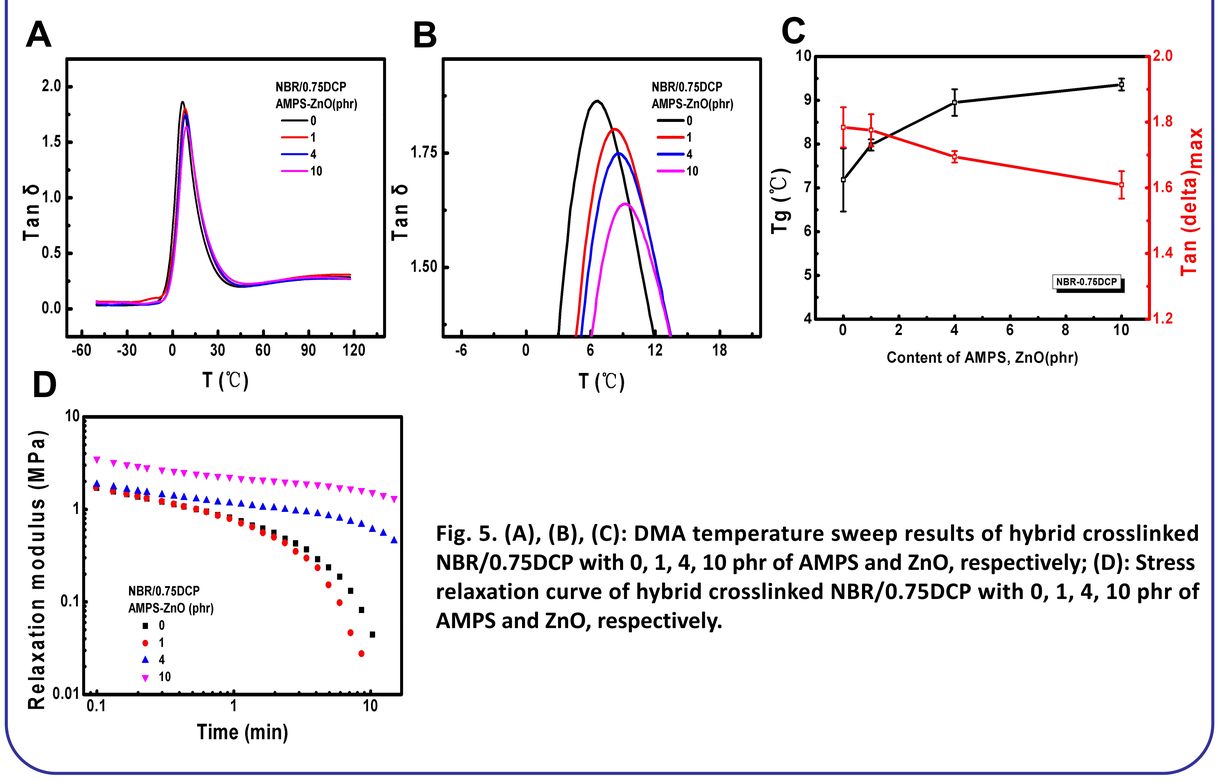

Fig. 5. (A), (B), (C): DMA temperature sweep results of hybrid crosslinked NBR/0.75DCP with 0, 1, 4, 10 phr of AMPS and ZnO, respectively; (D): Stress relaxation curve of hybrid crosslinked NBR/0.75DCP with 0, 1, 4, 10 phr of AMPS and ZnO, respectively.

Conclusions

1. The hybrid crosslinked NBR with covalent bond, ionic bond and hydrogen bond crosslinking was prepared.
2. The Young's modulus, dynamic storage modulus and crosslinking density were improved with the addition of AMPS and ZnO in hybrid crosslinked NBR.

Acknowledgement

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References

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