Improved mechanical properties and thermal degradation of lowtemperature hydrogenated acrylonitrile butadiene rubber composites with poly (sodium methacrylate) nanowires

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Fig. S1 TEM image of the rubber compound with 30 phr NaMAA before vulcanization. No nanowires can be seen.



Fig. S2 TGA and DTG curves of the composite prepared by mixing NaOH and MAA at the temperature of $30^{\circ}300^{\circ}$ C. An obvious DTG peak can be seen at the temperature of $^{-165^{\circ}C}$.

One dimensional structure of in-situ poly (NaMAA) in the rubber matrix

To prove the one dimension structure of in-situ poly (NaMAA), a lot of thin TEM sections were prepared. All ultra thin section specimens were from the same rubber sheet with the thickness of 2mm. They were divided by specimen orientations. Specimen orientations varied from parallel to vertical ones. Fig.2 in the main text is from the orientation of 90°. In contrast, Fig. S3 shows the typical TEM image sampling from the orientation of 45°. It is obvious that some nanowires exist in the rubber matrix. More TEM images from various orientations also exhibit the similar nanowires. So we believe that these images are powerful proofs to display the one-dimensional morphology of poly (NaMAA).





Experiments to obtain the quantity of self-polymerized NaMAA in the matrix.

To check the quantities of unreacted NaMAA, self-polymerization and grafting one of NaMAA in the rubber composites, the method of solution extraction was used (see: Y. Lu, Metallic salts of unsaturated carboxylate in-situ polymerization-reinforcing POE nano-composite. Master thesis: Beijing University of Chemical Technology; 2001.). As-prepared composites with poly (NaMAA) were firstly extracted by 125 ml methanol/ 25 ml hydrochloric acid mixture at the temperature of $50^{\circ}60^{\circ}$ C by soxhlet extractor. Residual NaMAA not to converse to poly (NaMAA) were extracted by the process. Then, they were further process secondary extraction by methylbenzene/methanol mixture (the weight ratio of 31: 69) after they were immersed in butanone/chloroacetic acid (the volume ratio of 70: 30) for 3 days. The weight variations caused by the secondary extraction is equal to the weight of self-polymerization of NaMAA (particles) because that poly (NaMAA) grafting to the rubber chains cannot be extracted by the mixtures. So by weighting the sample, the conversion, content of self-polymerization and grafting one of NaMAA was estimated.