TRANSLATION

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session of 2005/2006

April/May 2006

EBP 204/3 - Elastomeric Materials

Time : 3 hours

Please ensure that this paper consists of SEVEN printed pages before you proceed with the examination.

This paper contains SEVEN questions.

Answer any FIVE questions. If a candidate answers more than five questions, only the first five answered will be examined and awarded marks.

Answer to any question must start on a new page.

All questions must be answered in Bahasa Malaysia.

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1. [a] What is the importance of curing characteristics test for rubber compound? With appropriate diagram, discuss three stages of curing characteristics of rubber compound.

(40 marks)

[b] Give general formulation for rubber compound. With referring to various compounding ingredients that been used in rubber product manufacturing, discuss the function of each compounding ingredients that been used in your chosen general formulation.

(60 marks)

2. [a] Please show an example of rubber processing flow chart from raw rubber to rubber product, with identifying process involved. Give the definition of process involved and discuss the equipments that will be used.

(100 marks)

3. [a] Elastomeric materials are the unique materials that used in miscellaneous engineering applications. Briefly, discuss <u>two</u> elastomeric materials applications in engineering product that you know.

(60 marks)

[b] Referring to the engineering product that you choose, discuss in brief elastomer that are used and why it is been chosen.

(40 marks)

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4. [a] What is the meaning of sulphur accelerated vulcanization process? Explain how the choices of vulcanization systems can affect the tensile strength and ageing behaviour of elastomeric products?

(50 marks)

[b] Give main reasons why testing of crude rubber and its products need to be done.

(20 marks)

[c] Explain briefly how tensile test, tear test and abrasion test on rubber products were carried out.

(30 marks)

5. [a] Explain the main characteristics of carbon black which determine the reinforcement of rubber.

(30 marks)

[b] What do you know about coupling agent? Using silane coupling agent, Bis(triethoxysilylpropyl) - tetrasulfide (Si69) as an example, show the mechanism of action of this coupling agent in order to reinforce silica filed rubber compounds.

(40 marks)

[c] Guth introduces equation (1) to explain the reinforcement theory of rubber;

$$E = E_o (1 + 0.67f\phi + 1.62f^2\phi^2) \quad \text{----------} \quad (1)$$

What is the meaning of each term in equation (1)? In what condition the values predicted by equation (1) similar to values obtained from experiment?

(30 marks)

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6. [a] What are the negative effects which might occur due to poor dispersion of filler in rubber? Explain briefly the importance of various factors which influence the dispersion of filler in rubber.

(30 marks)

[b] With the help of a suitable figure, explain 4 main mixing stages of rubber with filler and other ingredients.

(30 marks)

[c] Figure 1 shows the rheological properties versus mixing time for uncured SBR compound. Explain the results obtained.

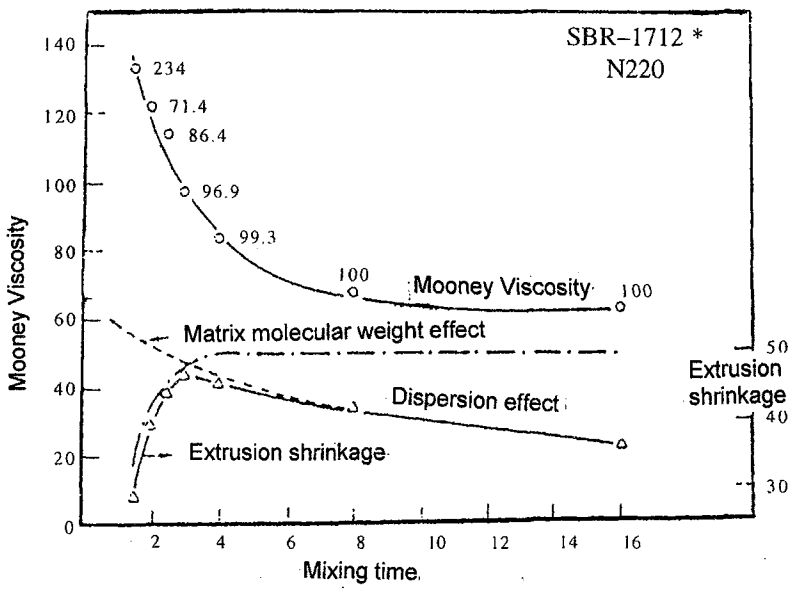

Figure 1 - Rheological Properties versus mixing time for SBR uncured compound (number refers to dispersion percentage of carbon black)

(40 marks)

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7. [a] Using the a suitable schematic, explain the difference between the structure of rubber nanocomposite and rubber microcomposite. What are the meaning of exfoliation and intercalation?

(30 marks)

[b] Table 1 shows the recipes of the organically modified clay and natural clay filled isobutylene - isoprene rubber (IIR) compounds.

Table 1 - Recipe of the IIR compounds*

Ingredients	Contents (phr)
IIR	100
Organic modified clay/natural clay	Varied
Zinc oxide	5
Stearic acid	2
Tetramethyl thiuram disulfide (TMTD)	1
2 - Mercapto benzothiazole	0.5
N-phenyl - α - naphthylamine	1
Sulfur	1.8

* 3 preparation methods were used;

(1) Solution intercalation - organic modified clay was used (S-IIRCN).

(2) Melt intercalation - organic modified clay was used (M-IIRCN).

(3) Natural clay was directly mixed with IIR on the two roll mill (M-IIRCM).

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Figure 2 shows the X-ray diffractometer (XRD) results of organic modified clay and M-IIRCN$_s$ containing 5, 10 and 15 phr organic modified clay. Figure 3 shows the dependences of mechanical properties of S-IIRCN, M-IIRCN and M-IIRCM on loading of clay (organic modified or nature). Explain the results obtained in Figures 2 and 3.

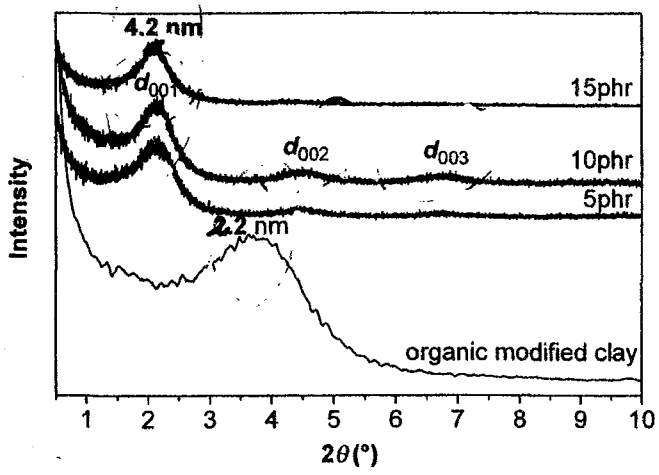

Figure 2 - XRD patterns of organic modified clay and M-IIRCNs (containing 5, 10 and 15 phr organic modified clay). The curves are vertically offset for clarity

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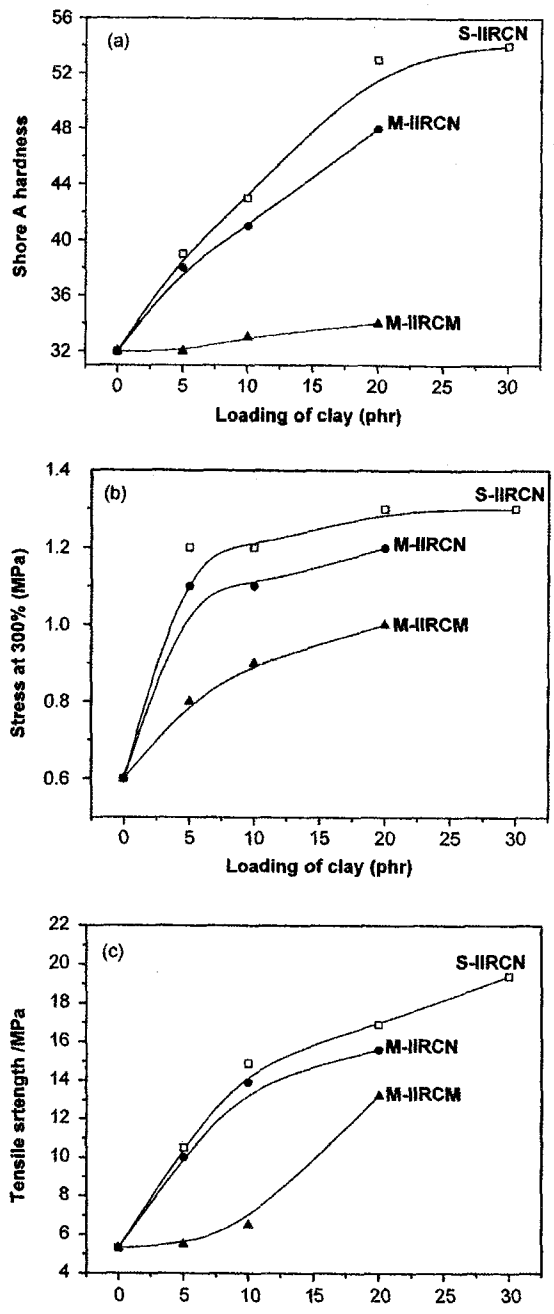

Figure 3 - Dependences of mechanical properties of S-IIRCN, M-IIRCN and M-IIRCM on loading of clay (organic modified or nature): (a) shore A hardness; (b) stress at 300%; (c) tensile strength 0 phr represents pure IIR vulcanizate

(70 marks)

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