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Reverse Engineering of Automotive Piston

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Why Reverse Engineering?

➢ In order to understand the existing direction of materials, present design, working details and manufacturing process of automotive piston.

Novelty

• Discovering the technological principles of a automotive piston through analysis of its structure and properties
• Getting ideas for new improved properties materials for new generation automotive piston.

Materials and Methodology

➢ A Proton Wira 1.3L car piston was distracted then cut and shaped to prepare standard samples for different tests.

➢ Tensile test was carried out on a 250 kN Instron screw driven UTM at a cross-head displacement rate of 5 mm/min for tensile properties of the material.

➢ Microstructural characterization of the piston material was performed using OM whereas EDX analyzer was used for elemental analysis of the piston material.

➢ A cylindrical bar shape (3 mm dia and 5 mm height) sample was prepared for pin-on-disk (POD) wear testing.

Result and Discussion

Tensile Properties

Figure 1 showed the stress-strain curve of the tensile test for the automotive piston alloy.

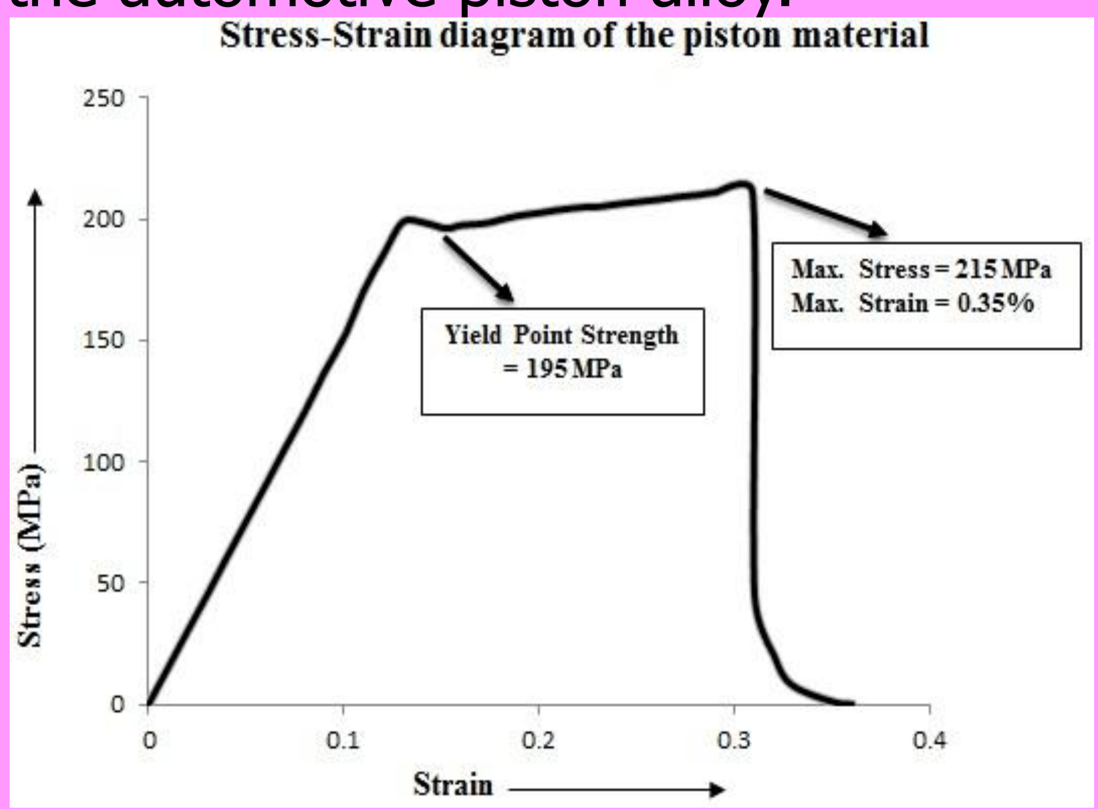

Fig 1: Stress-strain curve of the piston material.

Wear Properties

➢The wear rate is steadily increased up to 30 kg load and then decreased rapidly with increasing load both lubricated and dry sliding conditions which is shown in Fig 2.
➢ A marginal increment of the wear rate (both dry and lubricated condition) was observed with respect to sliding distance as presented in Fig 3.

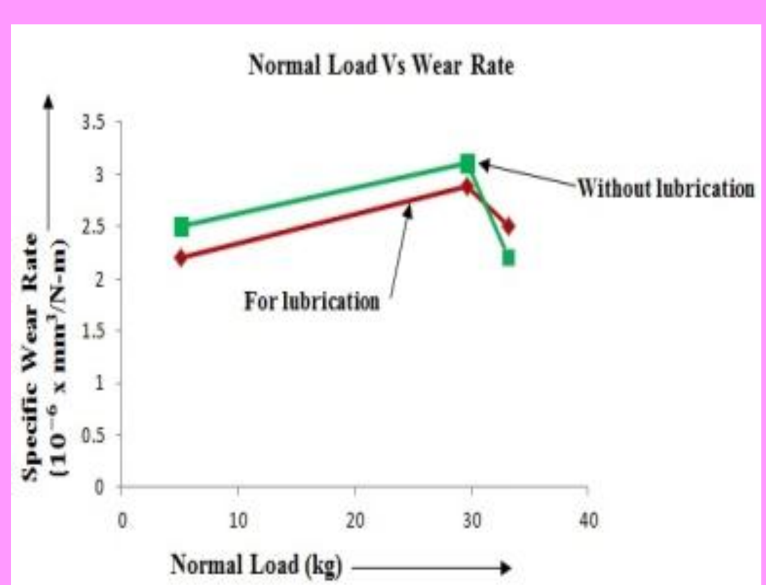

Fig 2: Specific wear rate verses normal load

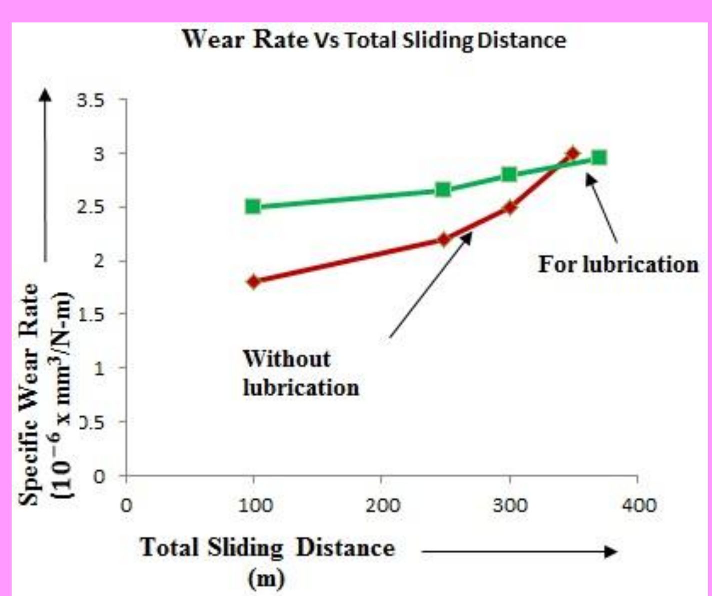

Fig 3: Specific wear rate verses sliding distance

Microscopy and Microstructure

➢ Microstructure showed well suited primary silicon and percentage defined the hypereutectic matrix (Fig 4).

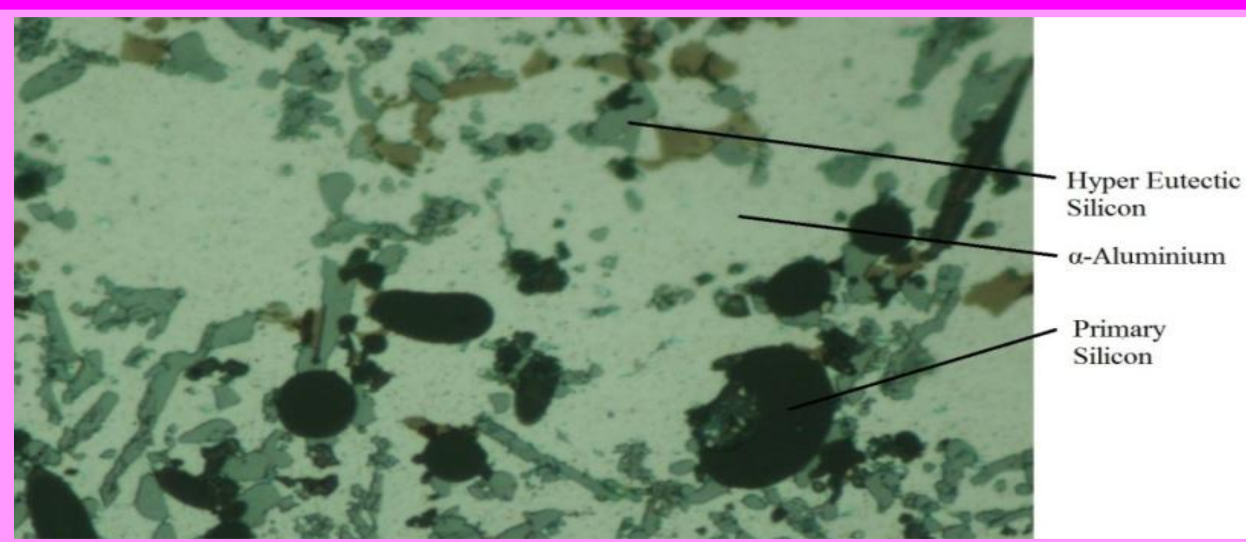

Fig 4: Optical microstructure of the piston alloy (500 magnifications).

EDX elemental analysis results showed that piston alloy falls under hypereutectic divergence alloy as shown in Table 1.

Table 1: Elemental analysis of the automotive piston material

Elements	percentage
Al	78
Si	17
Ni	0.80
Cu	1.51
Ag	0.82
Mg	0.21
Fe	0.53
Zn	0.65
Mn	0.32
Sn	0.06
Pb	0.10

Table 2 showed the values of surface roughness, R_a and the root mean roughness, R_q in nm.

Table 2: Av. Ra and Rq values of the specimen.

Conditions	Arithmetical average roughness, R_a (nm)	Root Mean Roughness, R_q (nm)
Before wear test	653	947
After wear without lubricant	638	898
After wear with lubricant	795	973

Conclusions:

➢The tensile properties of the piston are moderate. The current Proton Wira car piston contains 17% silicon and 78% Al hence it falls under hypereutectic Al-Si alloy system. Wear rate of piston is moderate.
➢ Therefore, new lighter weight and better properties of composite piston material can be proposed for new generation of piston.

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