# 과공정 AL-(18-25)Si-X 합금의 고온변형 특성 및 압출기술

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이재철***, 이호인***

(사) 한국소성가공학회 2001 년 제4회 압출 및 인발 심포지엄

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## Hypereutectic Al-Si-X Composites

**Advantages**

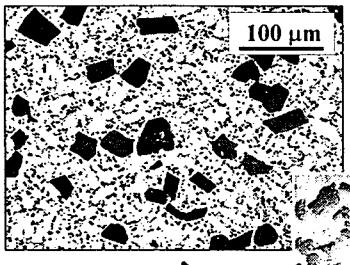
- ⇩ Excellent Wear Resistant Property
- ⇩ High Young's Modulus
- ⇩ Easy Recycling
- ⇩ Low Production Cost

**Disadvantages(Conventional Cast Al-Si-Xs Composite)**

- ⇩ Inferior machinability
- ⇩ Inferior Tensile Properties
- ⇩ Inferior Formability

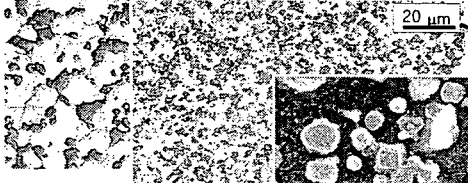
*Because of Coarse Si Paticles !!!*

## Controlling the Micro-Structure of the Composites

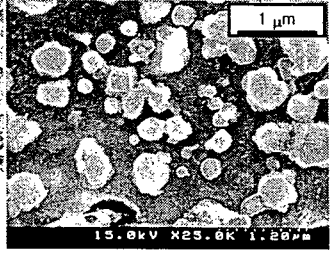



Al-18Si-Xs Alloy
Produced by Ingot Metallurgy


공정 변수 제어

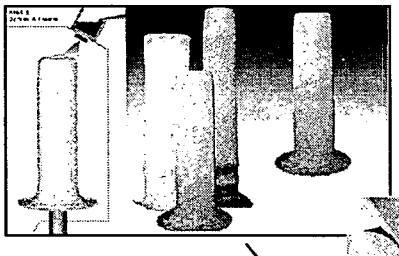



신합금 개발

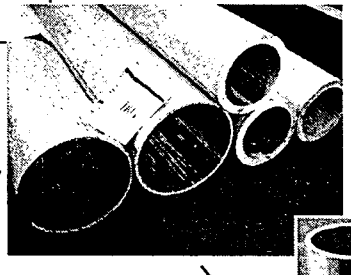



Al-18Si-Xs Composite
Produced by Spray Forming

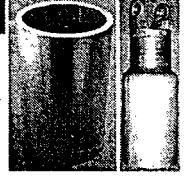
## Suggested Process



Spray Forming of
Hypereutectic Al-Si-Xs Alloy

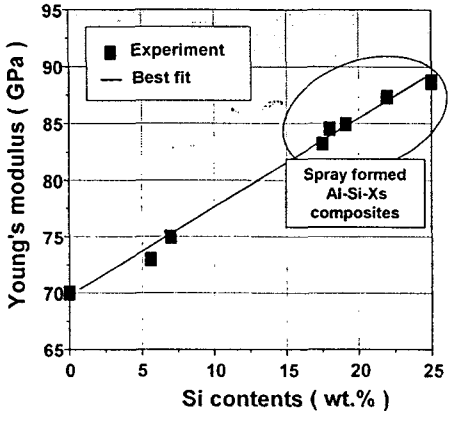


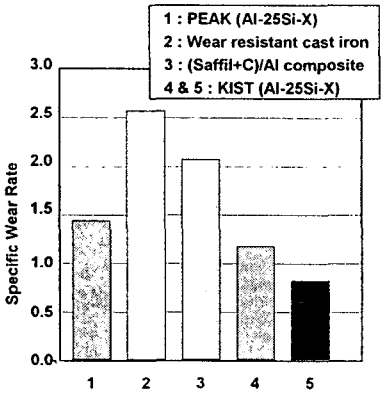
Extrusion of Spray Formed
Hypereutectic Al-Si-Xs Alloy



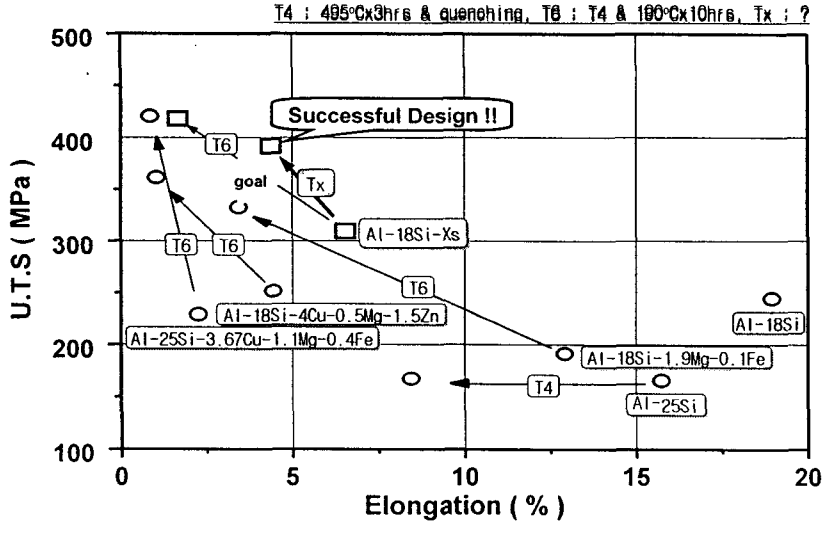
Development of End Items

## Mechanical Properties of the Spray Formed & Extruded Al-Si-Xs Composites

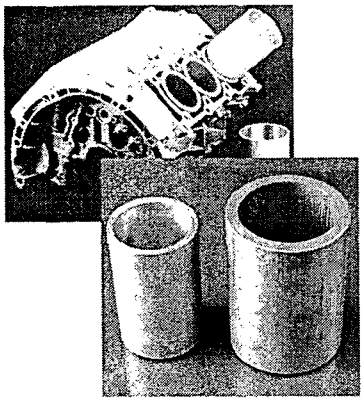



## Tensile Properties of the Spray Formed & Extruded Al-Si-Xs Composites



## Vehicle Parts Fabricated Using the Spray Formed & Extruded Al-Si-X Composites

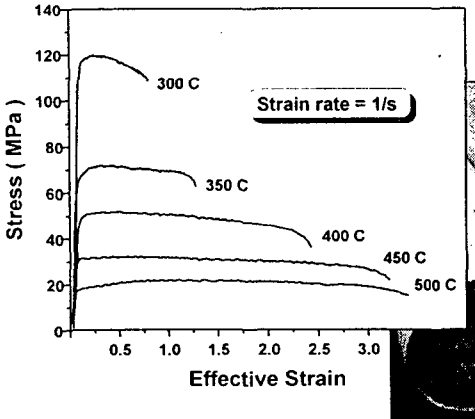


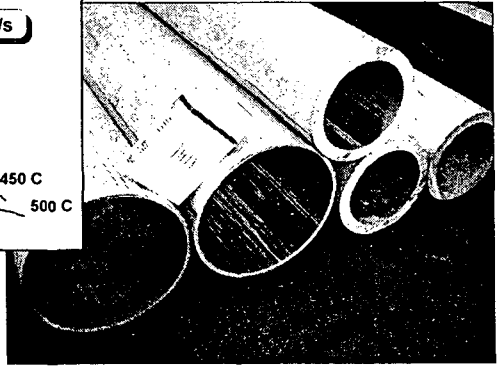

서울, COEX, 대서양관, 7.25-7.29

Gasoline Engine Cylinder Liner
- G7 과제
- 1998년, 국산화 기술 개발
- KIST, 두레, 현대자 공동 개발

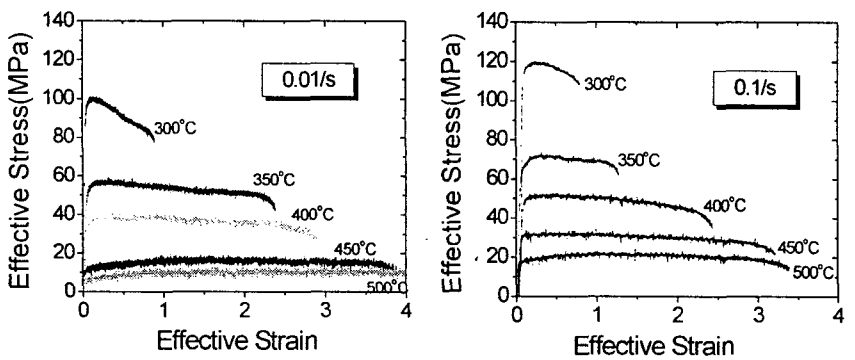
프로펠러 샤프트
- 중점국가과제
- 2001년, 고유 기술(미국, 한국 특허)
- KIST, 두레, 현대자, 대승 공동개발

## Extrusion of the Spray Formed Hyper Al-Si-X Composites Using Its Super Plasticity

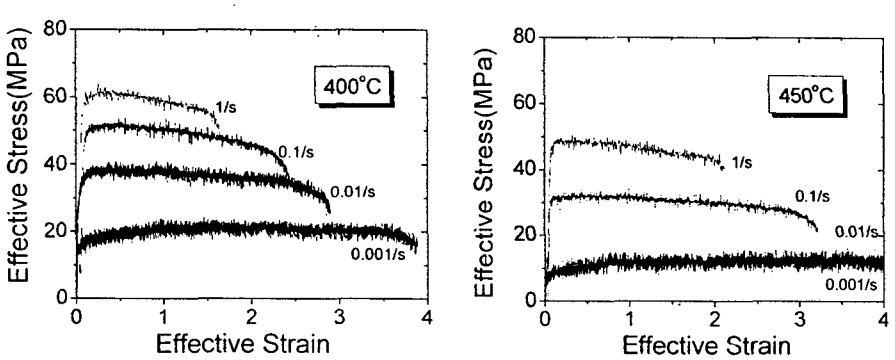


## Flow Curves for Constant $\dot{\varepsilon}$ (Torsion Test)

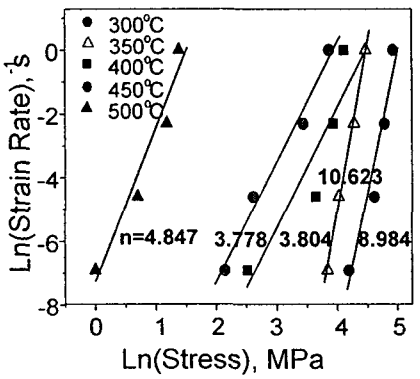


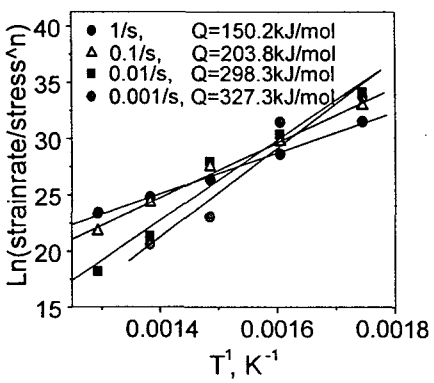

## Flow Curves for Constant T (Torsion Test)



## Constitutive Equation

$$\dot{\varepsilon} = 1.757 \times 10^8 \sigma^n \exp(-Q/RT)$$

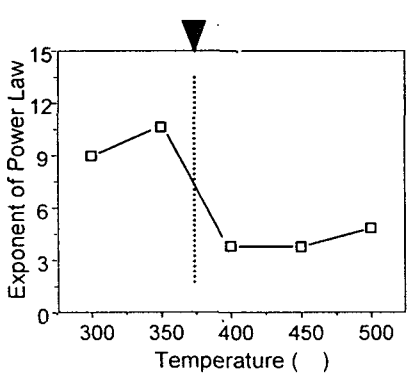


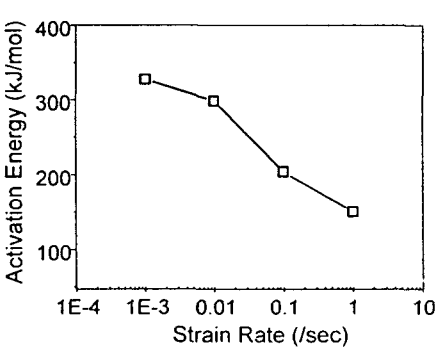




Dynamic Recrystalization (DRX) :
T<400°C, $\dot{\varepsilon}$ >0.1/s ( n = 9.80 Q = 177 kJ/mol)
Dynamic Recovery(DRV) :
T>400°C, $\dot{\varepsilon}$ < 0.01/s (n = 4.41 Q = 313 kJ/mol)

## Transition of Deformation Behaviors of the Spray Formed Hypereutectic Al-Si-X Composites

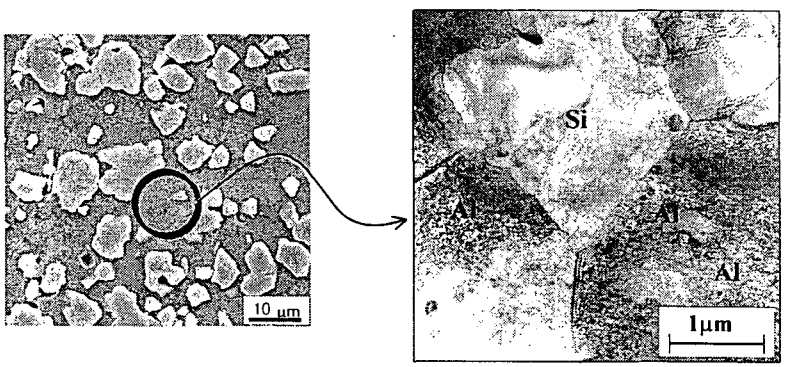
$$\dot{\varepsilon} = 1.757 \times 10^8 \sigma^n \exp(-Q/RT)$$



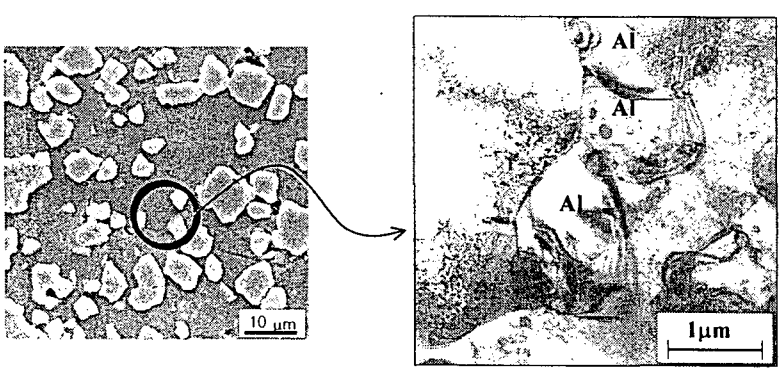

DRX : T<350°C, $\dot{\varepsilon}$ >0.1/s ( n = 9.80 Q = 177 kJ/mol)
DRV : T>400°C, $\dot{\varepsilon}$ < 0.01/s (n = 4.41 Q = 313 kJ/mol)

## Deformation at High Temperature and Low Strain Rate




Temp. ; 500°C, $\dot{\varepsilon}$ = 0.01/s
Where, n = 4.41 Q = 313 kJ/mol(DRV)

## Deformation at Low Temperature and High Strain Rate




Temp. ; 300°C, $\dot{\varepsilon}$ = 1/s
Where, n = 9.80 Q = 177 kJ/mol(DRX)

## Conclusions

- T<350°C, $\dot{\varepsilon}$ >0.1/s

⇩ **DRX behavior**
⇩ **Fine grain size**
⇩ **High Load for Extrusion**

- T>450°C, $\dot{\varepsilon}$ <0.01/s

⇩ **DRV behavior**
⇩ **Coarse grain size**
⇩ **Low Load for Extrusion**