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(SEDS)

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(Rapid Prototyping)

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CAD

(selective binding)

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(infiltration)

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Rapid Prototyping with Low Frequency Selective Electrical Discharge Sintering (SEDS)

A. Mirahmadi, S. Saedodin and Y. Shanjani
Department of Mechanical Engineering of Iran University of Science and Technology (IUST), Tehran, Iran

Abstract

Rapid prototyping with Low Frequency Selective Electrical Discharge Sintering (SEDS) is a new method in manufacturing of parts and masters. In this method, an electrical plasma arc provides the required thermal energy for initial binding. A polymeric coated metal powder as raw material is used in SEDS and initial binding is constructed by liquid phase sintering. Sequential layers are manufactured according to their CAD models. A moving electrode scans entire of the surface and the generated thermal energy of the plasma arc is exerted to the particle powders in the selective points of the powder bed. After manufacturing of all of the layers, the green part is removed from the built-chamber of the SEDS system and is put in the appropriate furnace to complete the sintering process. Then for decreasing the porosity and increasing the strength of the part, the infiltration process is done. The manufactured part in the SEDS method is a functional part. The SEDS method has some valuable potentials which provide the manufacturing of the large parts and masters.

Key words: Rapid prototyping, Binding, Sintering, Infiltration, Electrical plasma arc.

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(R&D)

(Selective Laser Sintering-SLS)

(Electron Beam Manufacturing-EBM)

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blacking

CAD

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(Selective Electrical Discharge Sintering -SEDS)

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SEDS - SEDS

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(green strength)

(binding)

. (sintering)

(infiltration)

. SEDS

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. SEDS

(binder)

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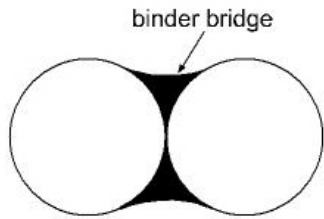
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Cu Ni, Bronze, Stainless Steel, Fe

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SLS EOS

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EOS -

Phosphoric Cu (Cu 90%+Sn 10%)	Nicke	Bronze
75%	5%	20%

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binder bridge

SEDS

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SEDS

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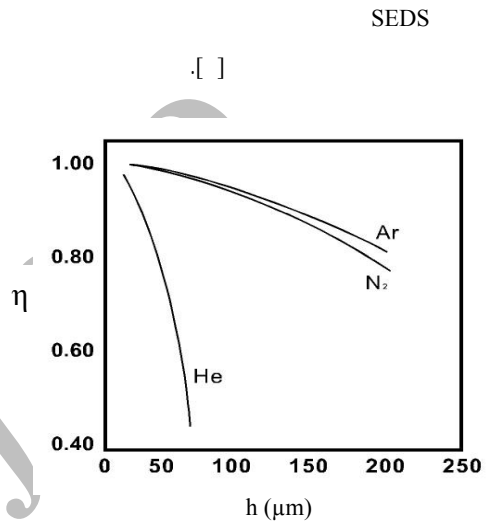
SEDS

(green part)

$1 \times 10^3 - 4 \times 10^3 \, \text{W} / \text{cm}^2$

$(6 \times 10^3 - 15 \times 10^3 \, \text{W} / \text{cm}^2 : \qquad)$

...

%

- %

(Liquid Phase Sintering -LPS)

- %

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$$\frac{1}{r^2} \cdot \frac{\partial}{\partial r}\left(r^2 \cdot \frac{\partial T}{\partial r}\right) + \frac{1}{r^2 \cdot \sin\theta} \cdot$$

(shape factor)

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$$\frac{\partial}{\partial\theta}\left(\sin\theta \cdot \frac{\partial T}{\partial\theta}\right) + \frac{1}{r^2 \cdot \sin^2\theta} \cdot$$

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$$\frac{\partial}{\partial\varphi}\left(\frac{\partial T}{\partial\varphi}\right) = \frac{1}{\alpha} \cdot \frac{\partial T}{\partial t} \qquad ( )$$

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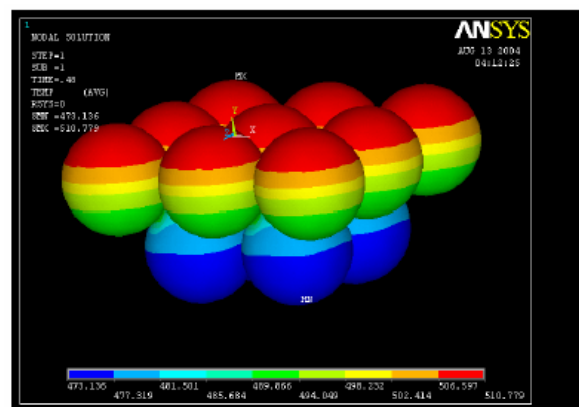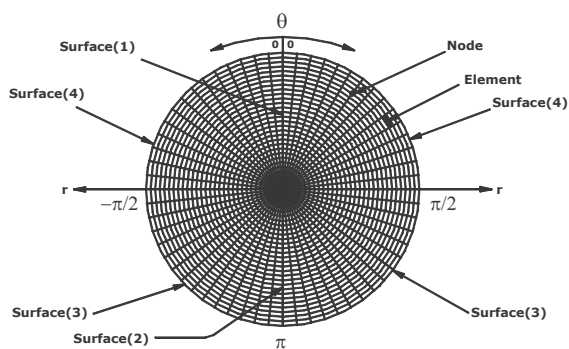
$$\left(\frac{\partial}{\partial\varphi}\right)$$

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$$\frac{1}{r^2} \cdot \frac{\partial}{\partial r}\left(r^2 \cdot \frac{\partial T}{\partial r}\right) + \frac{1}{r^2 \cdot \sin\theta} \cdot$$

$$q_{in} = q_\circ(t) \cdot \exp\left[-\left(\frac{r}{R}\right)^2\right] \quad q_\circ(t) = \frac{Q_{in}(t)}{\pi \cdot R^2} \quad ( )$$

$$\frac{\partial}{\partial\theta}\left(\sin\theta \cdot \frac{\partial T}{\partial\theta}\right) = \frac{1}{\alpha} \cdot \frac{\partial T}{\partial t} \qquad ( )$$

R . $Q_{in}(t)$

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$$1)\ @\ r = 0 \Rightarrow \left.\frac{\partial T}{\partial r}\right|_{r=0} = 0 \qquad ( )$$

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$$2)\ @\ 0 < r \le R \ \&\ \theta = 0 \Rightarrow \frac{\partial T}{\partial\theta} = 0 \qquad ( )$$

$$\eta = 1 - \left[2.10 \left(\frac{m}{M} \right)^{0.75} \cdot \left(\frac{h}{\lambda} \right)^{0.5} \right] \qquad (\ )$$

$= \eta$

$= m$

$= h$

$= \lambda$

$= M$

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$p \cong X^2 / 2R$

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$3)@ \, 0 < r \le R \, \, \& \, \, \theta = \pi \, \Rightarrow \frac{\partial T}{\partial \theta} = 0 \qquad (\ )$

$4)@ \, \, r = R \, , \, \frac{\pi}{2} < \theta \le \pi \Rightarrow q_r'' = 0 \qquad (\ )$

$$\left. \frac{\partial T}{\partial r} \right|_{r \, = \, R} = \mathbf{0} \qquad (\ )$$

:

$5)@ r = R \, \& \, \, 0 \le \theta < \frac{\pi}{2} \, \Rightarrow -k \, \frac{\partial T}{\partial r} = q_r'' \quad (\ )$

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$@ \, \, r = R \Rightarrow -k \, \frac{\partial T}{\partial r} = q_{\circ}(t) \cdot \exp[-(\frac{R \cdot \sin \theta}{a})^2] \cdot \cos(\theta) \quad (\ )$
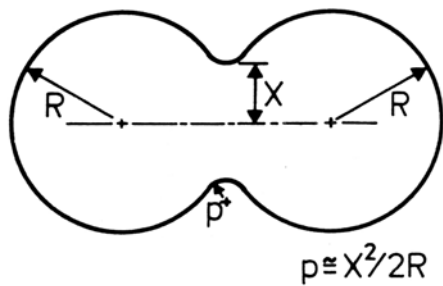
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$@ \, \, t \le 0 \, \, \Rightarrow T \, (r, \theta, 0) = T_{\circ} \qquad (\ )$

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LPS

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SEDS

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SEDS (MTC) .

SEDS .

. (capillary force)

. (infiltration)

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$P = P_r + \rho g Z$

Capillary Bundle

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( )

SEDS -

$$ x = \left(\frac{r_{eff}\, t\, .\gamma_{LV}\, .\cos\theta}{2\mu} \right) \qquad ( ) $$

. t θ r_{eff}

. μ

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SEDS -

SEDS .

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ABS PVC

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SEDS

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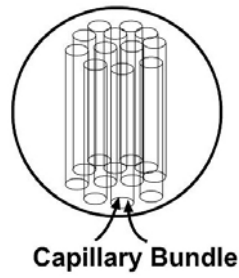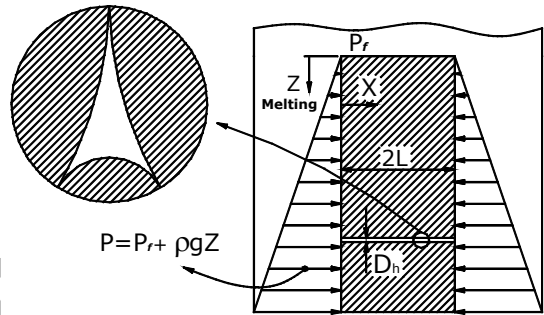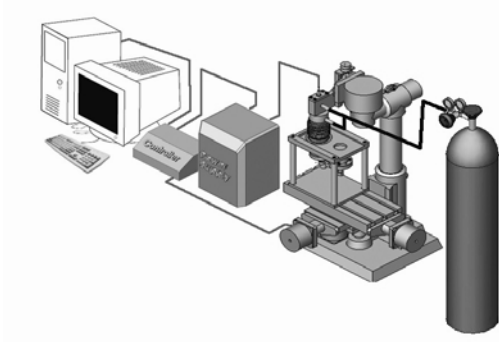
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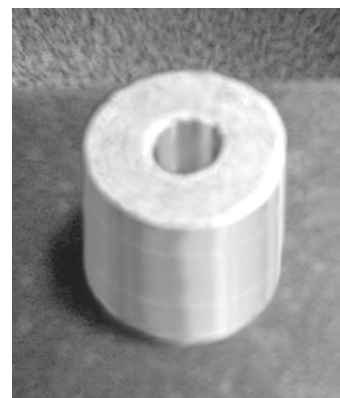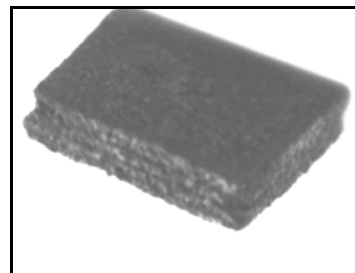
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SEDS -

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