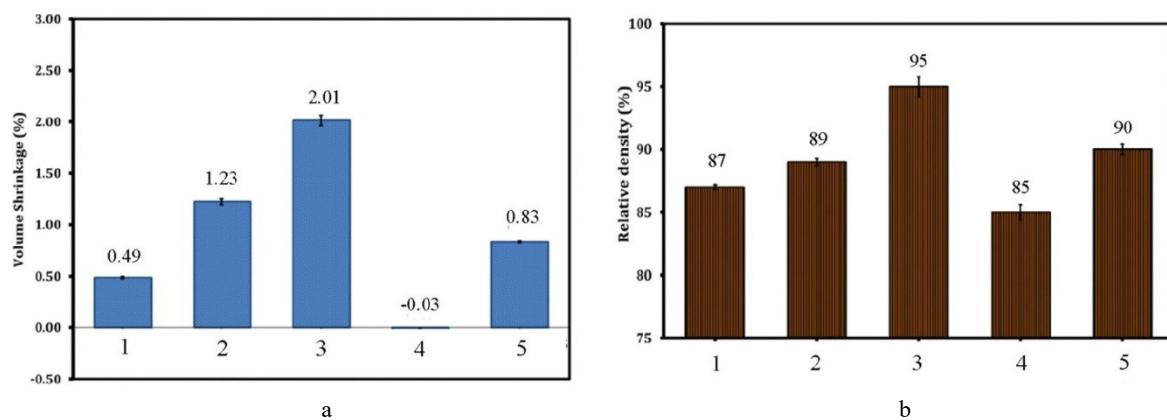


Supplementary Material

Table S1. Fluidity and apparent density of the powder mixtures before sintering.

| S. No. | Composition of powder | Apparent density ($\text{g} \cdot \text{cm}^{-3}$) | Fluidity (Seconds) |
|--------|-----------------------------|--|--------------------|
| 1 | Fe + 0.5% C | 2.83 | 38.3 |
| 2 | Fe + 0.5% C + 0.5% Ni micro | 2.64 | 41.3 |
| 3 | Fe + 0.5% C + 0.5% Ni nano | 2.62 | 43.6 |
| 4 | Fe + 0.5% C + 0.5% Co micro | 2.64 | 44.3 |
| 5 | Fe + 0.5% C + 0.5% Co nano | 2.63 | 44.6 |

**Fig. S1.** Volume shrinkage percentage (a), relative density of Fe+0.5% C alloy (b) without modifier (control) (1), micro nickel modified (2), nano nickel modified (3), micro cobalt modified (4) and nano cobalt modified (5).

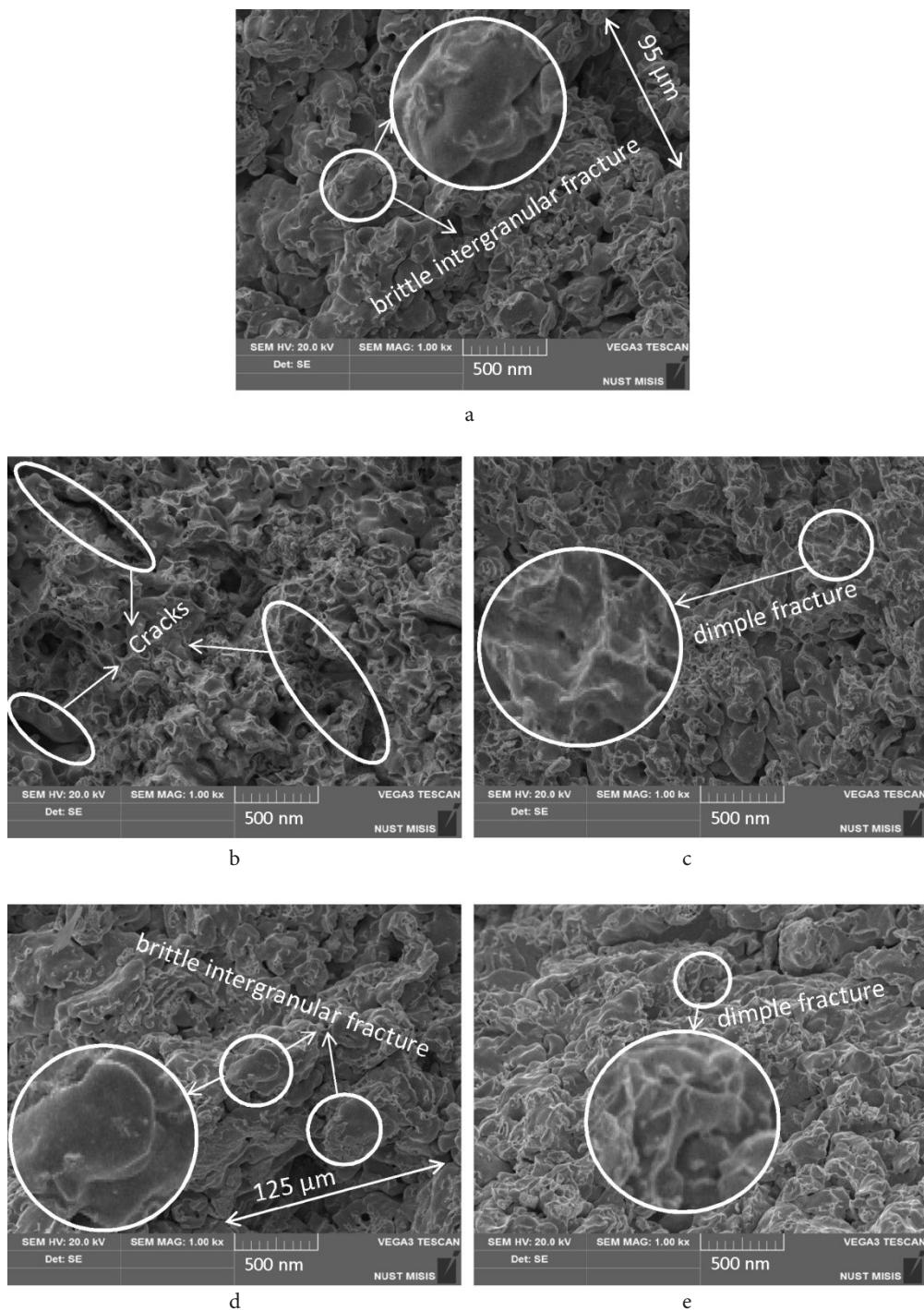


Fig. S2. Microstructures of fractured Fe+0.5% C alloy without modifier (control) (a), micro nickel modified (b), nano nickel modified (c), micro cobalt modified (d) and nano cobalt modified alloy (e).