Electronic Supplementary material

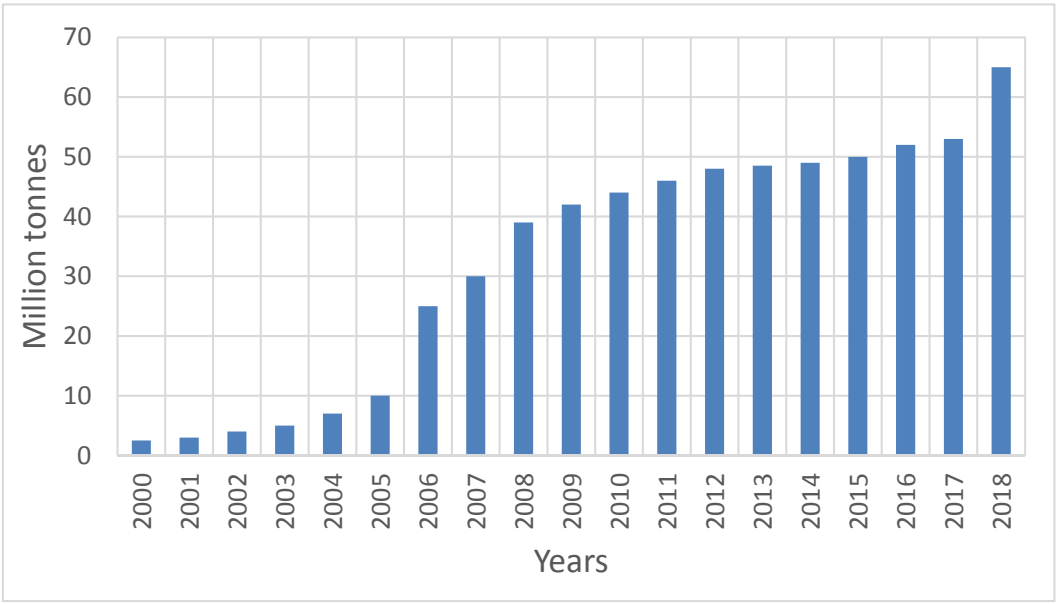

Fig. S1 Development of Nb micro-alloyed steel production in China.

Note: Since 2000 the Nb steel in China has been growing steadily, except in some years it stays still and the consumption does not decrease. Data source from Ref. [1].

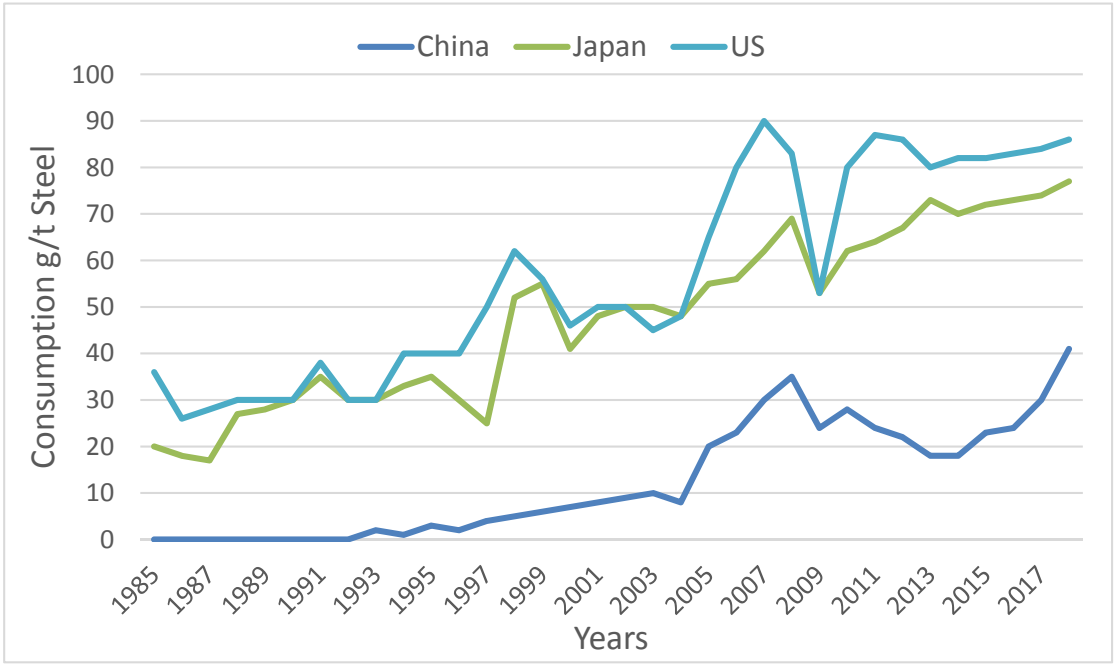

Fig. S2 FeNb consumption in steel.

Note: The gap between the consumption intensity of FeNb in micro-alloyed steel in China and the advanced level in foreign countries. Data source from Ref. [1].

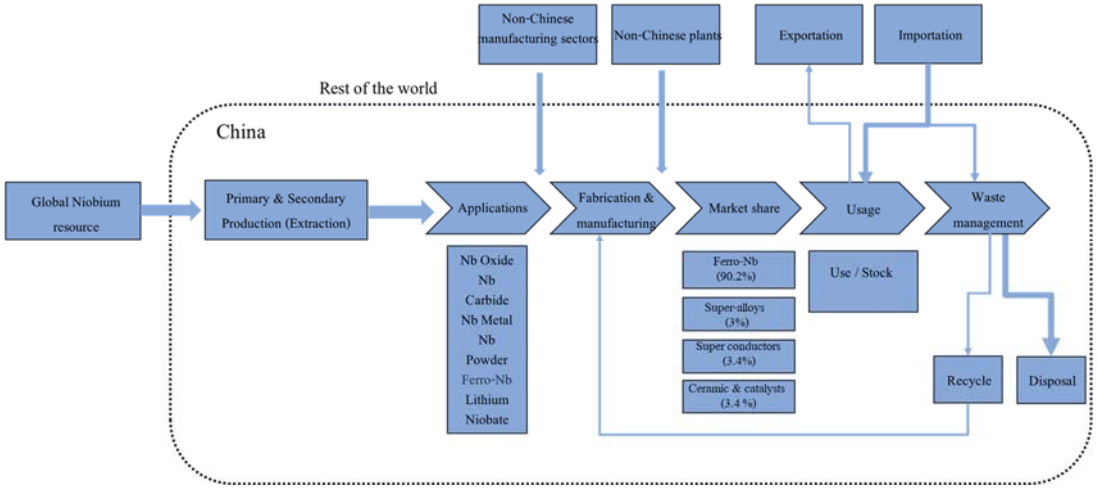

Fig. S3 Conceptual niobium material flow in China.

Note: Suggested flow modelling for Chinese niobium market, as illustrated in this model, is based on previous studies. The size of the arrow represents the amount of each process. For instance, the amount of niobium export is very few compared to the amount of Nb import. In addition, the import can be entering the country in the shape of waste metals which can be extracted and sent back to the fabrication and manufacturing process.

Table 1 Nb in steel share

Application	Percentage
OIL and gas pipeline	20%
Automotive	22%
Structural	40%
Stainless	8%
Total	90% of niobium's share

Note: As can be seen, most of the Nb production goes to structural and automotive which means recycling its scrap should have more research technologies in order to minimize the mining as much as possible. Therefore, it should be considered to the waste management authorities. Data source from Ref. [2].

Table 2 Foreign table of the mineral sector amounts in millions of USD (Refs. [3, 4])

Main exported products	2010	2011
Export mineral primary goods	35,360	43,595
Iron ore	28,912	35,745
Gold	1,786	1,988
Nb	1,557	2.034
Copper	1,238	1,806

Table 3 Nb market share (Refs. [5–7])

Products	Nb production	Major applications	Market
Standard-grade ferro Nb	90.2%	HSLA (High Strength Low Alloy) steel Stainless steel Heat-resistant steels	Automotive Structure Pipelines Petrochemical
Vacuum-grade alloys	3.0%	Super-alloys	Engines Power generation
Nb metals and alloys	3.4%	Super-conductor	Magnetic Resonance Imaging (MRI) Particle accelerators
Nb chemicals	3.4%	Catalysts Functional ceramics	Optical Electronics

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