

ENGINEERING MATERIALS

BMM1523

FERROUS & NON-FERROUS METALS

by

TEDI KURNIAWAN

Faculty of Mechanical Engineering
tedikurniawan@ump.edu.my

Chapter Description

- **Aims**

- To study the classification of ferrous and non-ferrous metals
- To differentiate different types non-ferrous metals

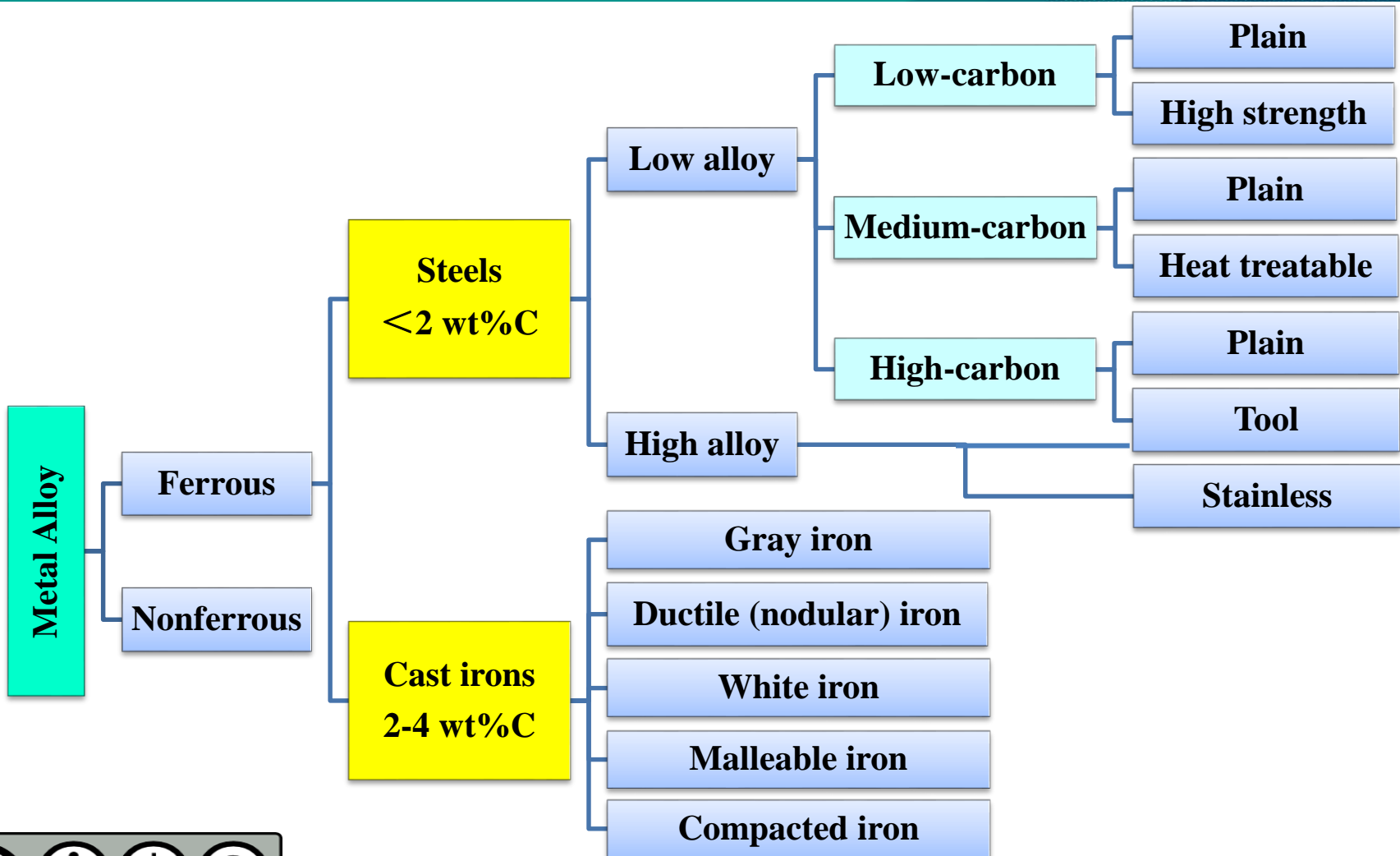
- **Expected Outcomes**

- Student will be able to describe and differentiate the major categories of ferrous alloys
- Student will be able to identify different types of non-ferrous alloys together their specific properties

- **References**

1. William D. Callister and David G. Rethwisch. Materials science and engineering: An Introduction, 9th Ed. Wiley, 2014.

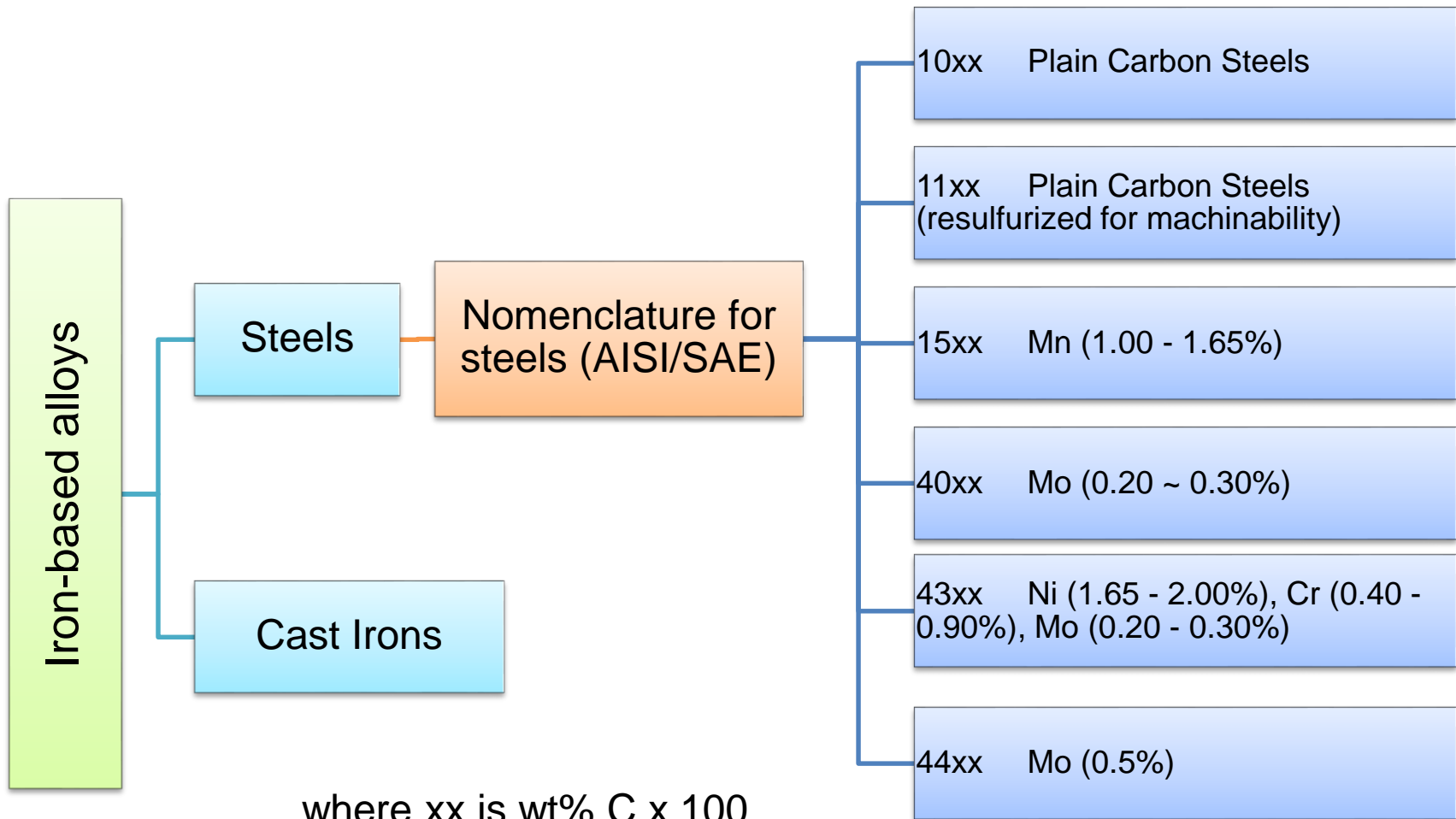
Classification of Metal Alloys



Steels

Steels	wt%C	Name	Additions	Uses
Low Alloy	Low Carbon <0.3	Plain	none	Automotive, metal sheets
		HSLA	Ni, Cr, V, Mo	Towers, bridges, press. vessels
	Med Carbon 0.6-0.6	Plain	none	Crank, shafts, bolts, hammers
		Heat treatable	Cr, Ni, Mo	Pistons, gears, wear applic.
	High Carbon 0.6-1.5	Plain	none	Wear applic.
		Tool	Cr, V, Mo, W	Drills, saws, dies
High Alloy		Stainless	Cr, Ni, Mo	High T, applic., turbines

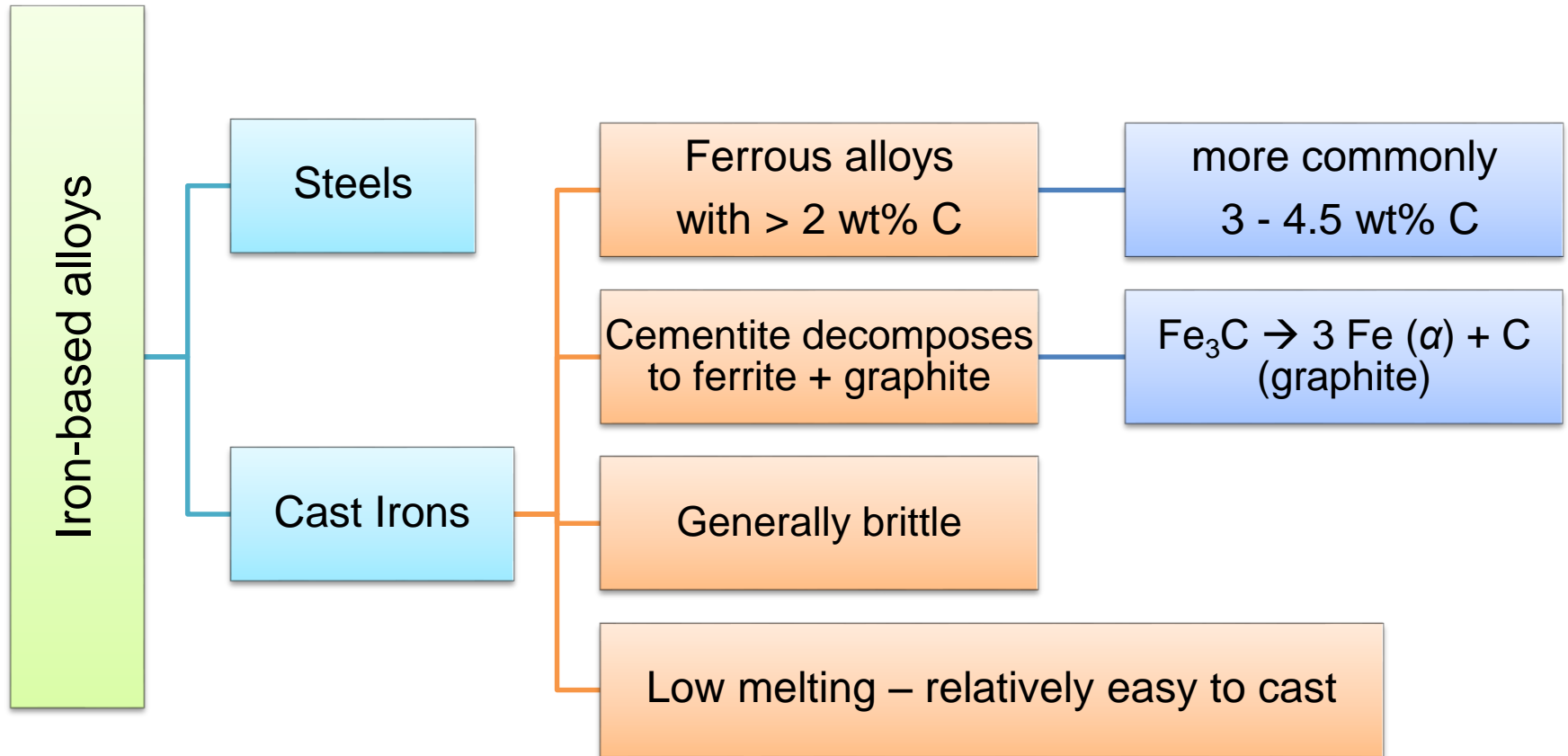
Ferrous Alloys



where xx is wt% C x 100

example: 1060 steel – plain carbon steel with 0.60 wt% C

Ferrous Alloys



Types of Cast Iron

Gray cast iron

- Grey fracture surface with 1-3 wt.% Si
- graphite flakes: good in compression, weak in tension
- Example: Engine blocks, flywheels

Ductile cast iron

- graphite in nodule shapes by addition of Mg and or Ce
- Can be cast in larger section
- Example: camshafts, gears

White cast iron

- White fracture surface with < 1 wt.% Si
- Cementite precipitates rather than graphite
- Very hard and brittle. Example: Bearing surface

Malleable cast iron

- heat treat white iron at 800-900°C
- Cementite transform into graphite in rosettes
- Example: axle bearing, crankshafts

Nonferrous Alloys

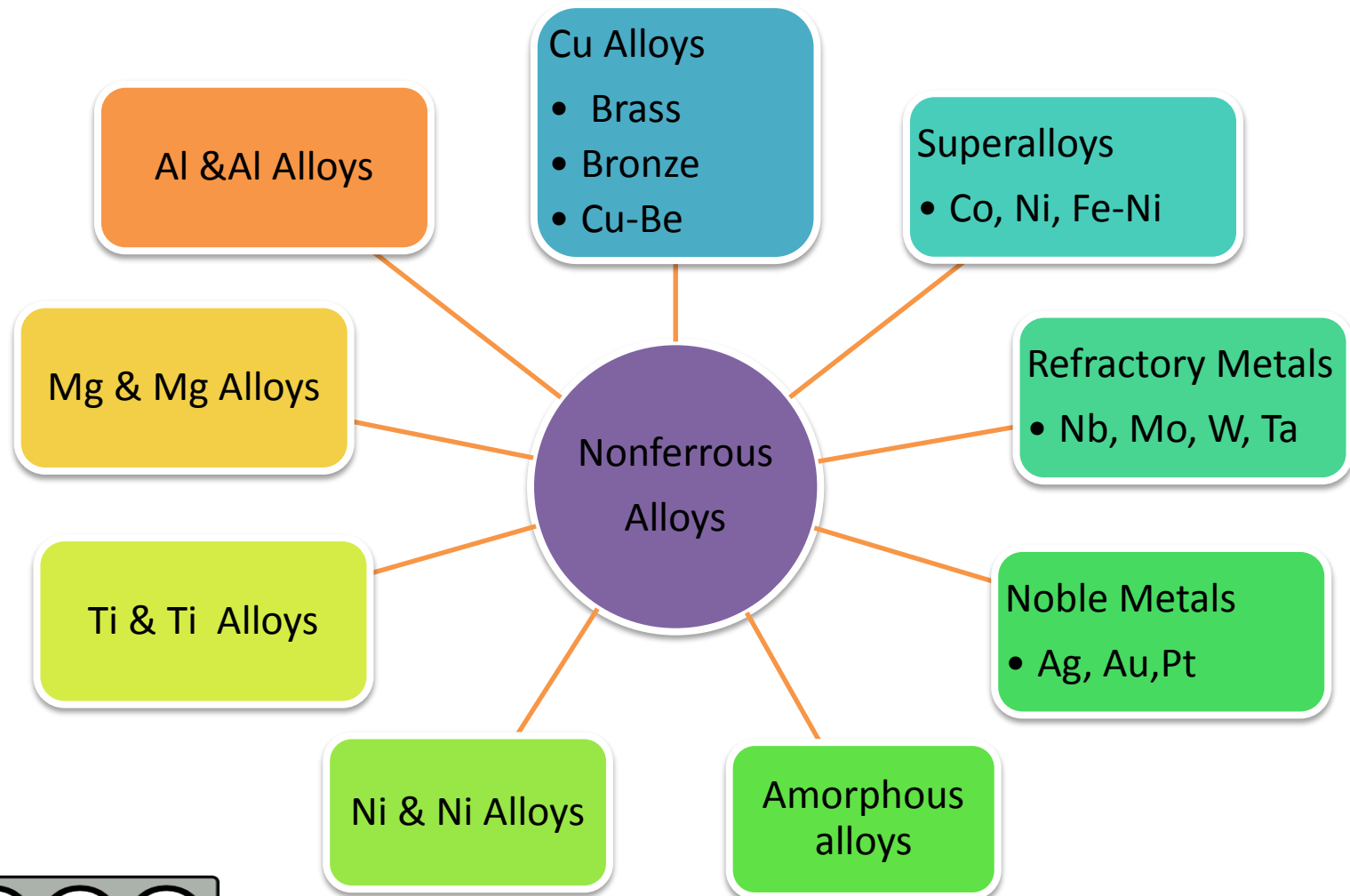
❖ Limitations of Ferrous Alloys

- Relatively high densities, low electrical conductivities and poor corrosion resistance.

❖ Nonferrous Alloys

- Wide range of materials → many options with specific properties.
- Important applications based on properties:
 - Corrosion resistance application
 - High thermal application
 - Electrical conductor application
 - Low density and easy to fabricate application

Nonferrous Alloys



FERROUS ALLOYS

Al and Al Alloys

- Good corrosion resistance,
- Good thermal and electrical conductivity,
- Good malleability and machinability,
- non magnetic, and
- Easy to recycle,
- Wide range of uses- aircraft, packaging, construction and etc.

Mg and Mg Alloys

Cu and Cu alloys

Ti and Ti alloys

Nickel and Nickel Alloys

FERROUS ALLOYS

Al and Al Alloys

Mg and Mg Alloys

- Lightest metal, density one third of Al
- Added to Al to improve welding and fabrication characteristic
- Mg powder Ignite easily in air
- Application based on lightweight: aircraft, luggage, laptop, bicycles, cameras, missile component, etc.
- 3rd abundant metallic element, mostly from sea water

Cu and Cu alloys

Ti and Ti alloys

Nickel and Nickel Alloys

FERROUS ALLOYS

Al and Al
Alloys

Mg and
Mg
alloys

Cu and Cu Alloys

- Good conductor for electrical and thermal application and good corrosion resistance
- Mostly uses in electrical components
- Tube and piping materials
- Most common copper alloys are brass (Zn addition) and bronze (tin addition)

Ti and Ti
alloys

Nickel
and
Nickel
Alloys

FERROUS ALLOYS

Al and
Al
Alloys

Mg
and
Mg
alloys

Cu
and
Cu
alloys

Ti and Ti Alloys

- As strong as steel but half its weight.
- Important alloying element for Al, Fe, Mo.
- Approximately 95% applied in the form of titanium dioxide (TiO_2)
- High strength (even at high temperatures), light weight, excellent corrosion resistance, and withstand extreme temperatures.
- Used in aircraft, armor plating, naval ships, spacecraft and missiles.

Nickel
and
Nickel
Alloys

FERROUS ALLOYS

Al and
Al
Alloys

Mg
and
Mg
alloys

Cu
and
Cu
alloys

Ti and
Ti
Alloys

Ni and Ni Alloys

- Malleable and ductile metal
- Very good corrosion resistance even at high temperature, good electrical and thermal conductor.
- High specific magnetic and thermal expansion
- Used as major alloying element in stainless steel, copper alloy (MONEL or NICORROS), and chromium alloy (HASTELLOY, NICROM, INCONEL, etc).

Dr. Tedi Kurniawan

Affiliation:

Structural Materials and Degradation (SMD) Focus Group
Faculty of Mechanical Engineering
University Malaysia Pahang
Pekan 26600 Pahang, Malaysia.

Research Interest:

- High Temperature Physical Chemistry
- Thin Films Technology
- Metals and Alloys.

Contact:

- Email: tedikurniawan@ump.edu.my

Dr. Jiang Xiaoxia

Affiliation:

Visiting Lecturer
Faculty of Mechanical Engineering
University Malaysia Pahang
Pekan 26600 Pahang, Malaysia.

Associate Professor
School of Mechanical Engineering
Ningxia University, China.

Contact:

- Email: jiangxiaoxia0201@gmail.com