NEMESIS — Novel Energy Materials: Engineering Science and Integrated Systems
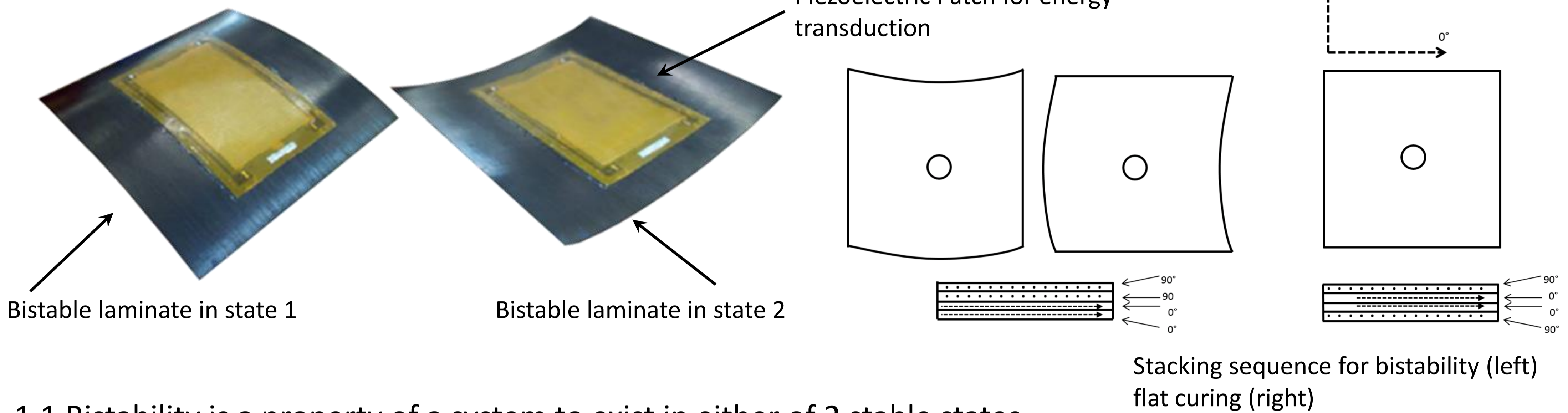
Peter Harris | P.J.Harris@bath.ac.uk
Chris Bowen | @BowenNEMESIS
Alicia Kim | @OptimiserAlicia

Energy Harvesting with Bistable Laminates

1. What is a bistable laminate?

Macro Fiber Composite (MFC) Piezoelectric Patch for energy transduction

Bistable laminate in state 1

Bistable laminate in state 2

Stacking sequence for bistability (left) flat curing (right)

1.1 Bistability is a property of a system to exist in either of 2 stable states.

1.2 We induce bistability by exploiting the difference in the thermal coefficients of expansion of unidirectional carbon fiber pre preg sheets in asymmetric stacks.

1.3 How is energy produced? As the laminate vibrates, the piezoelectric patch is strained, producing electrical energy .

2. Why is bistability useful? The nonlinearity from bistability leads to a broader band response from vibration Energy.
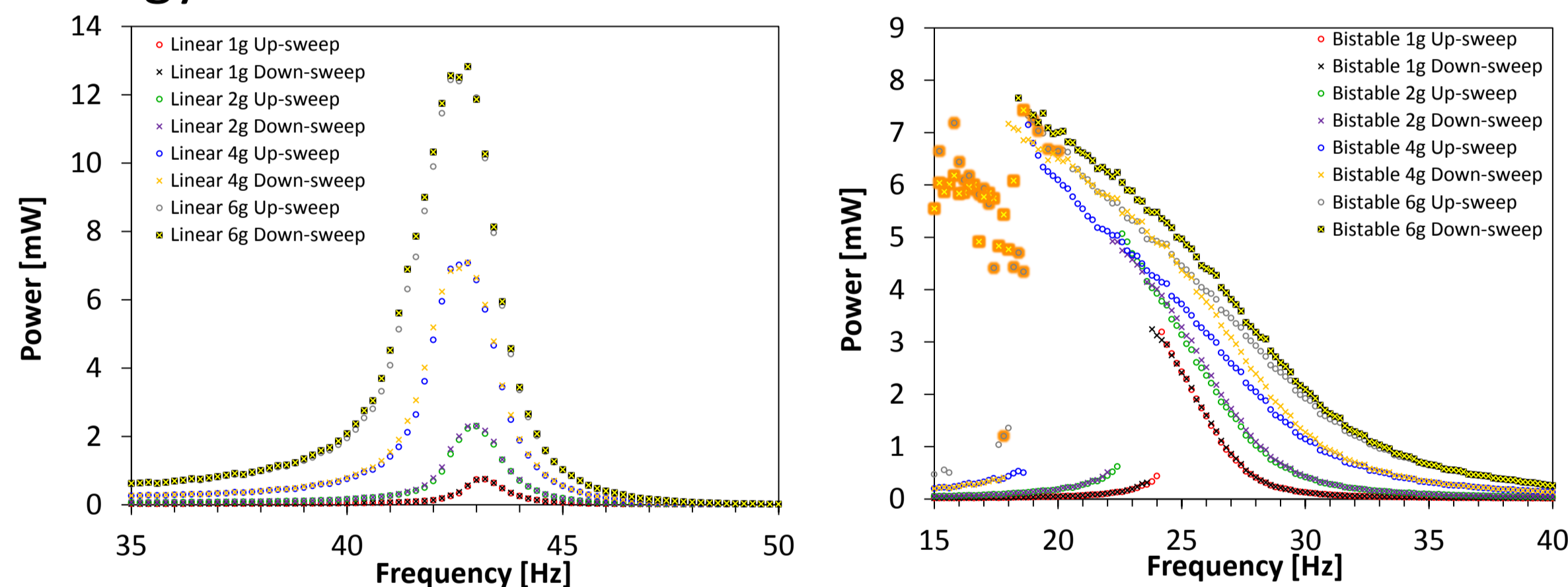
|	Linear		Bistable		
	Mode 2	Mode 3	Mode 1	Mode 2	g-level
Peak power [mW]	0.738	0.930	3.19	0.023	1
FWHM [Hz]	1.1	2.7	1.9	3.3	
Peak power [mW]	2.29	3.04	5.06	0.069	2
FWHM [Hz]	1.4	3.0	3.3	3.5	
Peak power [mW]	7.07	10.15	7.14	0.15	4
FWHM [Hz]	1.8	3.4	6.6	5.1	
Peak power [mW]	12.83	20.07	7.3	0.268	6
FWHM [Hz]	2.1	3.8	8.4	6.6	

All from [1]

3. What does the design space look like?
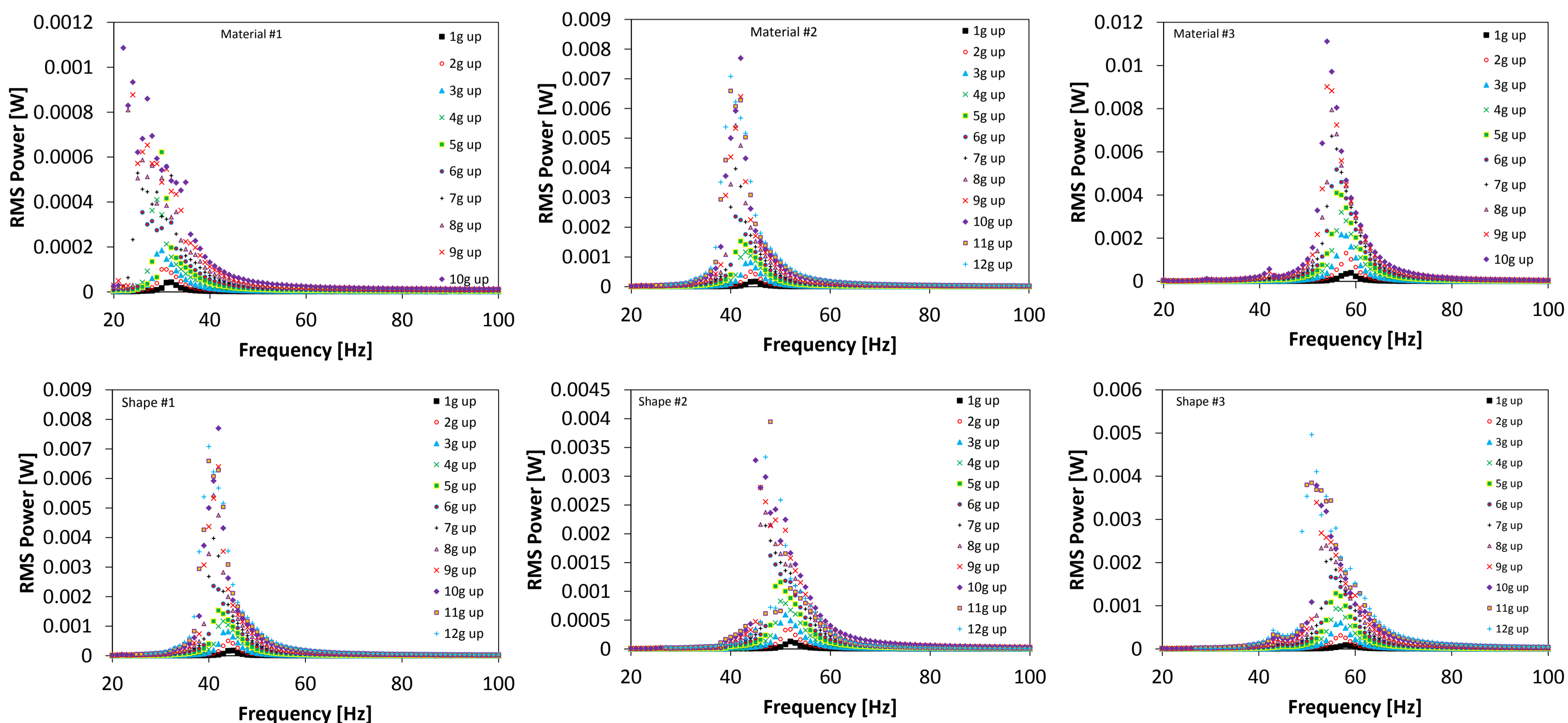
(Left to right) increasing substrate stiffness

(Left to right) decreasing laminate area
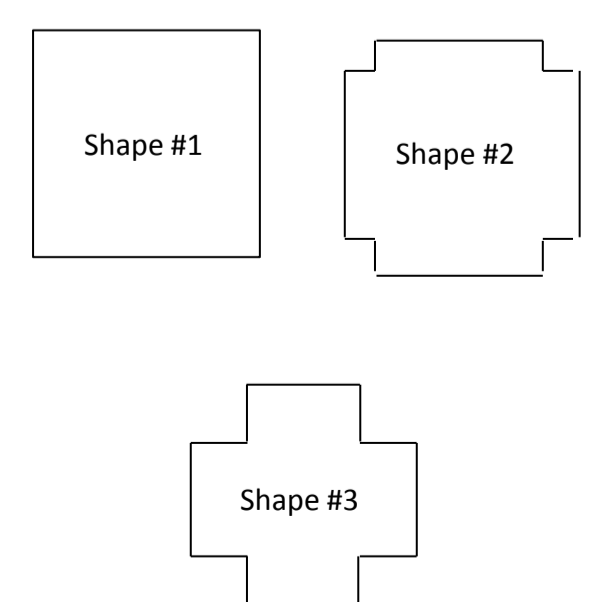
[1]Harris, et. al, Journal of Multifunctional Composites, 3 (2014) 113–123, Manufacture and Characterisation of Piezoelectric Broadband Energy Harvesters Based on Asymmetric Bistable Laminates