

# Electronic Supplementary Material

## Silicon-containing reactive dyes for acidic fixation on cotton and their application in one-bath one-step dyeing of polyester/cotton blends

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### 1. Supplementary Figures

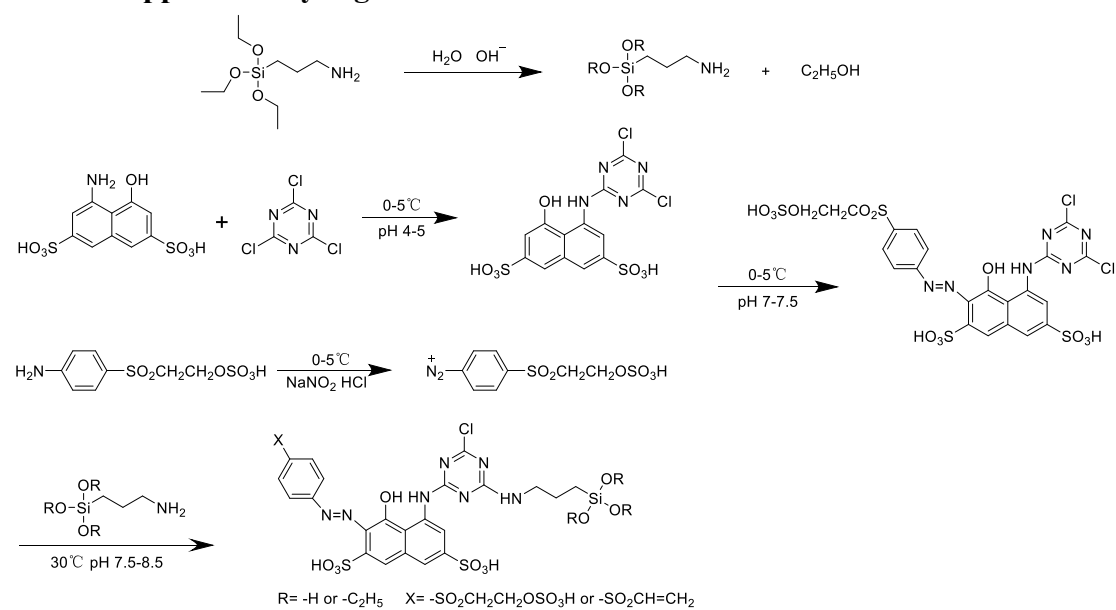


Fig. S1 Synthesis of DR

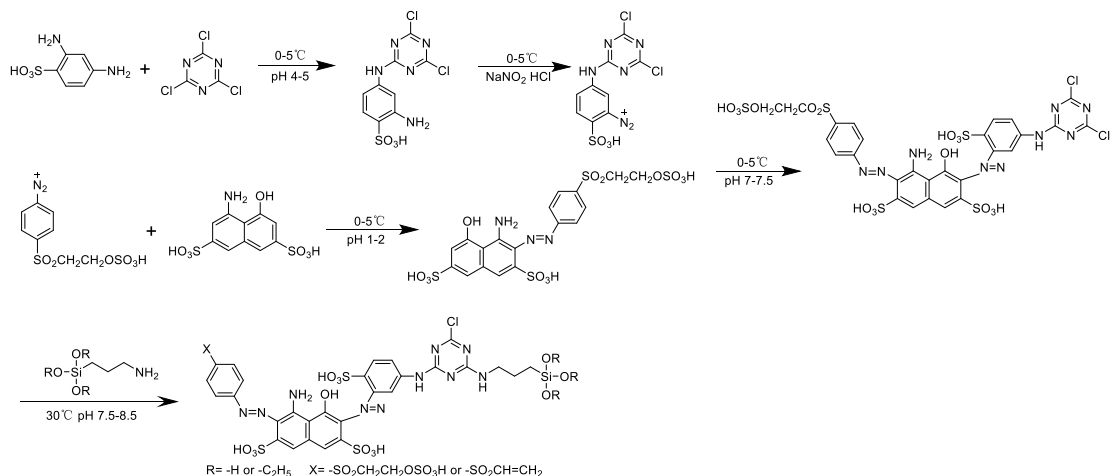


Fig. S2 Synthesis of DB

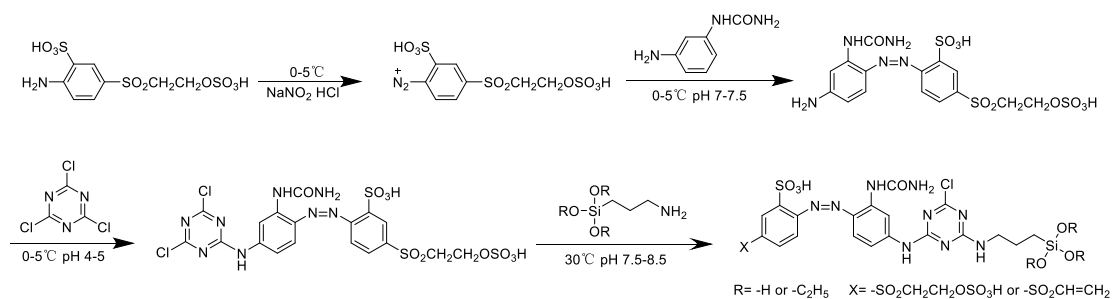


Fig. S3 Synthesis of DY

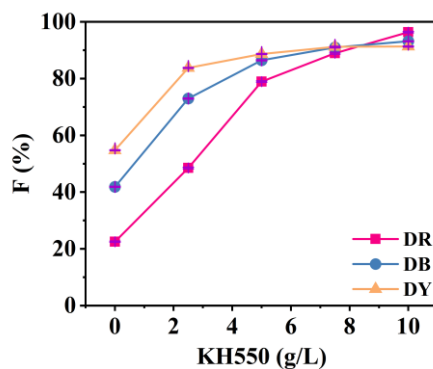


Fig. S4 Effect of KH550 on the fixation rate of silicon-containing reactive dyes in acidic dyeing

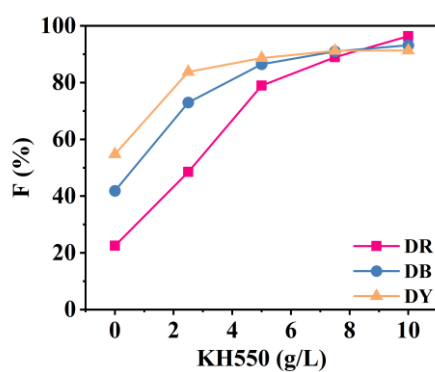


Fig. S5 Effect of steaming time on the fixation rate of silicon-containing reactive dyes in acidic dyeing

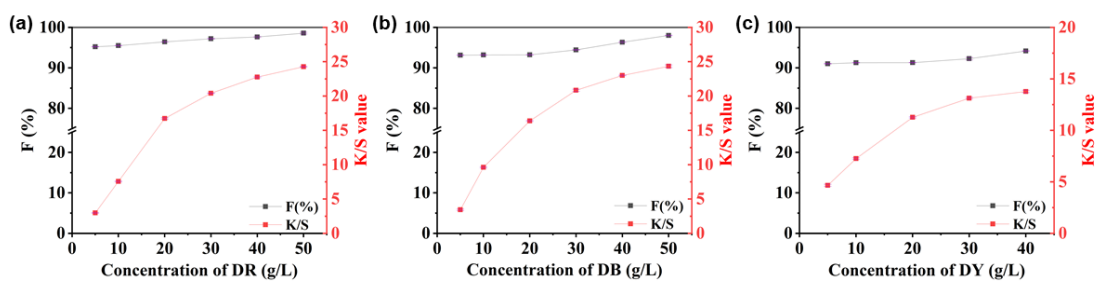


Fig. S6 Dyeing performance of the silicon-containing reactive dye at different concentrations

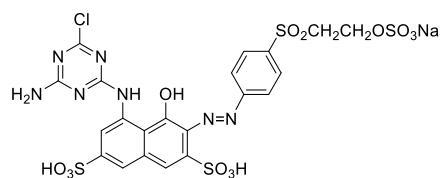


Fig. S7 Structure of control dye CR

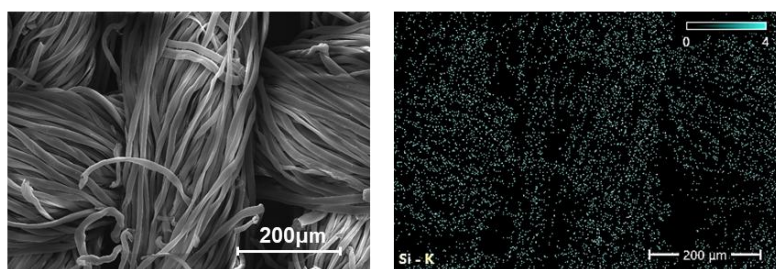


Fig. S8 SEM-EDS image of cotton fabric after KH550 treatment



Fig. S9 Photos of DR solubility in water before and after steaming

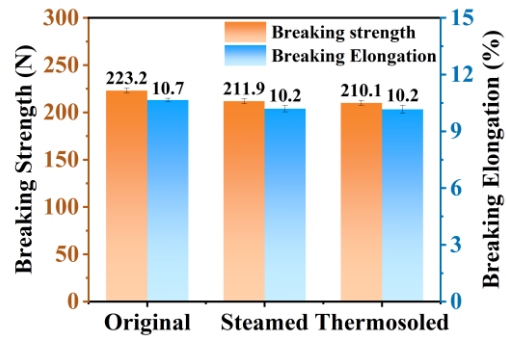


Fig. S10 Changes in breaking strength and breaking elongation of cotton fabric after sequential steaming and thermosol treatments

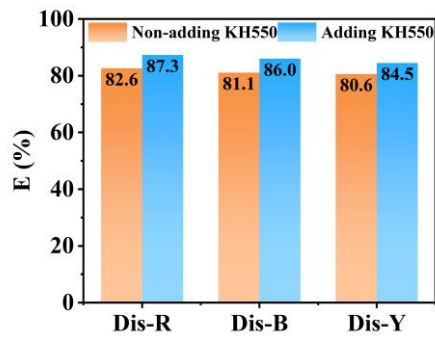


Fig. S11 Effect of KH550 on fixation rates of disperse dyes

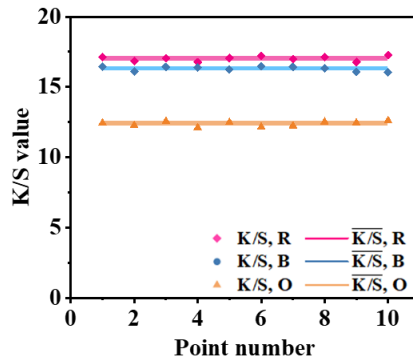


Fig. S12 Distribution of K/S values across the dyed fabric

## 2 Energy consumption calculation

The dyeing processes of one-bath one-step and two-bath two-stage for polyester/cotton blends were shown in figure S2 and figure S3. The resource consumption is calculated based on the processing of 1 ton of polyester/cotton blended fabric, with the process parameters as follows: fabric speed 8 m/min, fabric weight 160 g/m<sup>2</sup>, fabric width 1.5 m, and processing time 8.7 h.

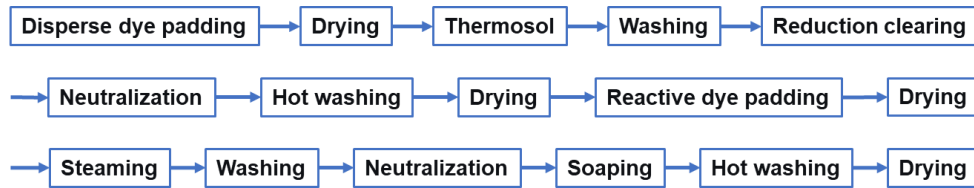


Figure S13 The dyeing processes of two-bath two-stage for polyester/cotton blends

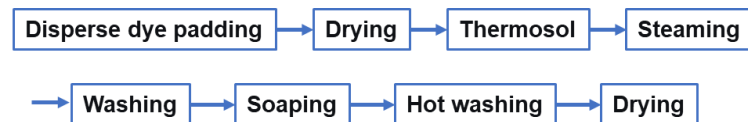


Figure S14 Dyeing processes of one-bath one-step for polyester/cotton blends.

### 2.1 Water consumption

The dye liquor pick-up rate is 60%, and the liquor ratio for soaping, washing, and reduction clearing is 1:50.

- Water required per dye padding = 1 t × 60% = 0.6 m<sup>3</sup>
- Water required per washing step = 50 m<sup>3</sup>

Total water consumption for the two-bath two-step process = 301.2 m<sup>3</sup>

Total water consumption for the one-bath one-step process = 150.6 m<sup>3</sup>

Water saving ratio: 50%

### 2.2 Electricity consumption

- Each drying process evaporates 600 kg of water (pick-up rate 60%), electricity consumption = 600 kg × 2260 kJ/kg = 2712 MJ

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- Thermosol fixation heats the fabric to 200°C,  $\Delta T = 180^\circ\text{C}$ , electricity consumption =  $1000 \text{ kg} \times 1.2 \text{ kJ/kg/}^\circ\text{C} \times 180^\circ\text{C} = 216 \text{ MJ}$
  - Padding machine power 10 kW, processing time 8.7 h, electricity consumption per padding =  $10 \text{ kW} \times 8.7 \text{ h} = 87 \text{ kWh} = 313 \text{ MJ}$

Total electricity consumption for the two-bath two-step process = 11690 MJ

Total electricity consumption for the one-bath one-step process = 5953 MJ

Electricity saving ratio: 49.1%

### 2.3 Heat consumption

- Reduction clearing (50°C):  $\Delta T = 30^\circ\text{C}$ , energy consumption =  $50,000 \text{ kg} \times 4.18 \text{ kJ/kg/}^\circ\text{C} \times 30^\circ\text{C} = 6270 \text{ MJ}$
- Hot washing (60°C):  $\Delta T = 40^\circ\text{C}$ , energy consumption =  $50,000 \text{ kg} \times 4.18 \text{ kJ/kg/}^\circ\text{C} \times 40^\circ\text{C} = 8360 \text{ MJ}$
- Soaping (95°C):  $\Delta T = 75^\circ\text{C}$ , energy consumption =  $50,000 \text{ kg} \times 4.18 \text{ kJ/kg/}^\circ\text{C} \times 75^\circ\text{C} = 15675 \text{ MJ}$
- Steaming consumes 500 kg steam (0.5 kg/kg fabric), energy consumption =  $500 \text{ kg} \times 2257 \text{ kJ/kg} = 1129 \text{ MJ}$

Total heat consumption for the two-bath two-step process = 39794 MJ

Total heat consumption for the one-bath one-step process = 25164 MJ

Heat saving ratio: 36.8%