



Extended Data Figure 10 | Optical properties of multi-junction $\text{MoSe}_{0.96}\text{S}_{1.04}$ - $\text{WSe}_{0.92}\text{S}_{1.08}$ lateral heterostructure. **a**, SEM image of a three-junction $\text{MoS}_{2(1-x)}\text{S}_{2x}$ - $\text{WS}_{2(1-y)}\text{Se}_{2y}$ monolayer lateral heterostructure. Scale bar, $2\ \mu\text{m}$. **b**, **c**, Raman (**b**) and photoluminescence (**c**) spectra of points 1 to 4; and interfaces. **d**, Normalized photoluminescence spectra from a line scan perpendicular to the three junctions, regions 1 to 4 in **a**, as indicated in the inset of Fig. 3e ($\lambda_{\text{exc}} = 633\ \text{nm}$). **e**–**g**, Raman intensity maps corresponding to the optical image in Fig. 3b, at frequencies $412\ \text{cm}^{-1}$

($A_{1g(\text{S-W})}$ modes, **e**); $402\ \text{cm}^{-1}$ ($A_{1g(\text{S-Mo})}$ mode, **f**) and $354\ \text{cm}^{-1}$ ($E_{2g(\text{S-W})}$ modes, **g**). **h**, Raman position mapping between 399 – $417\ \text{cm}^{-1}$. There is a thin line of $\text{MoS}_{2(1-x)}\text{S}_{2x}$ between the $\text{WS}_{2(1-y)}\text{Se}_{2y}$ strip along the vertex direction which could not be resolved during the Raman mapping. **i**, **j**, Photoluminescence intensity map, corresponding to the optical image in Fig. 3b, at $1.67\ \text{eV}$ ($\text{MoSe}_{0.96}\text{S}_{1.04}$ domain, **i**) and $1.8\ \text{eV}$ ($\text{WSe}_{0.92}\text{S}_{1.08}$ domain, **j**). Scale bars: **e**–**j**, $10\ \mu\text{m}$.